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ORIGINAL ARTICLES.

I.—A Retrospect of Palæontology in the last Forty Years.[1]

(Part II.)

In any retrospect of scientific progress there are always special points, 'golden milestones,' along the road by which we travel, which mark unusual stages in our journey. Zittel, in his "History of Geology and Palæontology," fixes the 'heroic period' from 1790 to 1820, when the great masters of our science, Werner, Pallas, Saussure, Hutton, Playfair, William Smith, Leopold von Buch, Alexander von Humboldt, Alex. Brongniart, and Cuvier arose and laid the foundations of Geology.

The more recent development from 1820 to the close of the century may seem like an unbroken line of advance in geology and palæontology; but such is not the case. Special events of scientific interest from time to time, like the arrival of reinforcements, have given us fresh support and encouragement. The establishment of Geological Surveys in this country, in America, and on the Continent added an enormous onward impulse to such investigations, as did also the meetings of the Geological Society of London and its publications. The establishment of the British Association in 1830, and the increasing tendency to teach Natural Science in our great Universities, have stimulated and encouraged a very large number of ardent workers to enter the geological field. Nor must we forget the interest which the writings of Sedgwick, Buckland, Murchison, Lyell, Phillips, Forbes, Ramsay, Geikie, and many others, produced in the minds of students who came under their influence.

But the most powerful and wide-spreading impulse given to geological and palæontological investigations was undoubtedly due to the publication by Charles Darwin of his "Origin of Species," and the revolution caused by the introduction of the doctrine of 'the variation of species,' which the older naturalists had never admitted, having always treated them as permanent and immutable ideas. Only those of us who have lived through the period between 1858 and 1878 can fully realize the vast and radical change in the current

[1] Part I. of "A Retrospect of Geology," appeared in our January number, 1904, pp. 1–6.—Edit. Geol. Mag.

of scientific thought which was brought about in the minds of men by Darwin's teaching. In making a retrospect of the work recorded in this journal from 1864 to the present time, the evolution of geological and palæontological ideas is most marked, and it is no small gratification to feel that the GEOLOGICAL MAGAZINE has been enabled to incorporate in its pages so much valuable material in aid of the progress of both these sciences.

As has been stated in the earlier part of this Retrospect, the GEOLOGICAL MAGAZINE has had the satisfaction of publishing articles from a large number of early and celebrated geologists, many of whom alas are now no longer with us.

FOSSIL PLANTS.—We record with pleasure the name of Professor John Phillips, who, in 1865, described an interesting specimen of fossil wood bored by *Teredo* and enclosed in flint, from the Chalk of Winchester, preserved in the Oxford Museum. Professor E. W. Claypole, of Ohio, described and figured the oldest known tree, *Glyptodendron Eatonense*, from the Upper Silurian, Eaton, Ohio, U.S.A. No fewer than eighteen valuable contributions on Palæobotany (from 1865 to 1885) have been made by our old colleague, William Carruthers, on Carboniferous plants; Mesozoic Cycadean stems and fruits; on the petrified forest near Cairo; and the plants of the Brazilian Coal-beds; nor must we omit to mention his admirable lecture at the Royal Institution "On the Cryptogamic Forests of the Coal Period" (1869, pp. 289–300). Another distinguished botanist, Sir W. T. Thiselton-Dyer, wrote in 1872 on the Coniferæ from Solenhofen, and on fossil wood from the Eocene of Herne Bay and the Isle of Thanet. In 1868 George Maw described some flower-like forms from the leaf-bed of the Lower Bagshot, Studland Bay. Professor H. A. Nicholson recorded the existence of plants in the Skiddaw Slates. Dr. O. Feistmantel contributed notes on the Fossil Flora of Eastern Australia and Tasmania, dealing with those from the Tertiary, Secondary, Carboniferous, and Devonian formations. Walter Keeping described some early plant-remains from the Silurian of Central Wales, in which he endeavoured to discriminate between tracks and markings made by annelids and other animals and those left on these old rocks by seaweeds and other simple plants. Dr. Constantine Baron von Ettingshausen wrote on the Tertiary Floras of Australia and New Zealand, and J. S. Gardner on the Mesozoic Angiosperms and Flowering or Phanerogamous Plants, in which an exhaustive examination is made of the Oolitic, Cretaceous, and Tertiary Plants of the British Isles, as known to the author in 1886. Henry Woodward described some fragmentary Mesozoic plant-remains from South Australia.

In later years A. C. Seward took up the subject of Fossil Botany, described the stems of *Calamites undulatus*, the leaves of *Cyclopteris* from the Coal-measures of Yorkshire, and wrote on the specific variation in *Sigillariæ*; E. A. Newell Arber followed and defined the *Glossopteris* flora, and discoursed on Homœomorphy among Fossil Plants. Plant-remains from British Columbia and from Argentina have also been described.

Foraminifera.—Sir William Logan was the first to announce the discovery (November, 1864, p. 225) of the Foraminifer '*Eozoon*' in the Laurentian rocks of Canada, and Sir J. W. Dawson contributed "new facts" (in 1888), and "evidence for the animal nature of *Eozoon Canadense*" (in 1895). But the inorganic nature of this supposed most ancient fossil seems to be now very generally admitted, although Dr. Carpenter and Sir William Dawson long and valiantly laboured to maintain its integrity as one of the Protozoa.

The Nestor of Palæontology, Professor T. Rupert Jones, wrote on Foraminifera from the Bridlington Crag; *Orbitoides* from Malta and the West Indies; on Jurassic Foraminifera of Switzerland and the Chalk and Chalk Marl of South and South-East of England; in company with Professor W. K. Parker he elucidated those of the Chalk of Gravesend, and listed Eley's Foraminifera from the English Chalk; whilst with C. D. Sherborn he described the Jurassic Microzoa of Wiltshire, etc. Dr. H. B. Brady enumerated and figured *Involutina liassica* from the Lias of England, and 8 species of Tertiary and Carboniferous Foraminifera from Sumatra. He reported upon some 28 species from the 'Chalk' of the New Britain group, of which he observed: "After washing this Chalk it could not possibly be distinguished, by its organic remains, from a washed sample of 'Globigerina-Ooze' dredged in 1,500 to 2,500 fathoms in the South Pacific. May not the rock (he asks) be part of a recent sea-bottom disturbed by volcanic or other agency." He also wrote on those remarkable flask-shaped Foraminifera of the genus *Lagena*, from the Upper Silurian of Malvern. A. Vaughan Jennings described the Orbitoidal Limestone of North Borneo. Professor W. J. Sollas defined two new species of the genus *Webbina* and other Foraminifera from the Cambridge Greensand, and Walter Keeping the zone of *Nummulina elegans* at White Cliff Bay, Isle of Wight. F. Chapman and C. D. Sherborn discoursed on the Foraminifera of the London Clay, and F. Chapman on Hyaline forms from the Gault, also upon *Patellina* and 23 other genera and species from the Tertiaries of Egypt. A. K. Coomáraswámy wrote on the Radiolaria *Spongodiscus* and *Dictyomitra* from the Upper Gondwána series near Madras.

Porifera—Sponges. — Dr. H. B. Holl contributed a carefully written article on Fossil Sponges, in which, after describing their various structures in considerable detail, he strongly advocated their minute microscopic examination and comparison with living forms, and said: "In conclusion, the Sponges appear to have endured through a long range of time, subject only to modifications which scarcely amount to specific distinctions." Dr. G. J. Hinde explained the structure of *Archæocyathus minganensis* from the Palæozoic (Mingen) strata of Canada; Sponge-remains from the Chert and Siliceous Schists of Permo-Carboniferous age of Spitzbergen; wrote on *Stephanella sancta*, a new genus of sponge from the Lower Silurian, Ottawa, Canada; and on *Palæosaccus Dawsoni*, a new Hexactinellid sponge from the Quebec group (Ordovician), Little Mitis, Canada. The discovery of this fossil

by Sir William Dawson made known an abundant sponge-fauna in rocks previously considered to be unfossiliferous. Professor Sollas figured and described a Vitreo-hexactinellid sponge from the Cambridge Coprolite-bed, which he named *Eubrochus clausus*. Dr. G. J. Hinde (1886) showed that *Eophyton? explanatum*, Hicks, and *Hyalostelia fasciculus*, described by Dr. Hicks as plants, were really sponges, and he illustrated their microscopic structure.

Graptolites.—Among the authors who have contributed to the study of this group of organisms must be specially mentioned the names of Professor H. Alleyne Nicholson, William Carruthers, John Hopkinson, Professor Chas. Lapworth, Linnarsson, and Holm. Lapworth wrote on the Classification of the Rhabdopora (1873) and on the Scottish Monograptidæ (1876); Hopkinson on *Dicranograptus*, *Dicellograptus*, and on Scottish Graptolites; Carruthers on the systematic position of Graptolites, and a revision of British species. Nicholson described the Graptolitic shales of Dumfriesshire and the Lower Silurian Graptolites of South Scotland, and noticed some associated reproductive bodies. E. T. Newton figured Graptolites from Peru. Dr. G. Holm, of Stockholm, described and figured some most beautiful Swedish Graptolites belonging to *Didymograptus*, *Tetragraptus*, and *Phyllograptus*. T. S. Hall wrote on the Graptolite-bearing rocks of Victoria, Australia; while Dr. O. Hermann contributed an important paper on the Organisation and Economy of Graptolites, and Dr. G. Linnarsson gave their vertical range in Sweden.

Corals.—One of the most valuable papers on Corals was that by Dr. Gustav Lindström (1866) dealing with those remarkable *operculated* forms from the Silurian — *Goniophyllum pyramidale*, *Rhizophyllum Gotlandicum*, and *Hallia calceoloides*, found at Wisby, I. of Gotland, and from our own Wenlock Limestone—closely related to *Calceola sandalina*, Lamk., from the Eifel Devonian, found also at Torquay, Devonshire, and described in 1873 by the Rev. T. R. R. Stebbing. These fossils were formerly placed with the Brachiopoda. Professor H. A. Nicholson contributed eight papers on *Cystiphyllum*, *Hemiphyllum*, *Favosites*, *Cleistopora*, etc., and R. F. Tomes seven essays on the *Madreporaria*. Professor P. Martin Duncan wrote on *Axosmilia longata* from the Inferior Oolite. Dr. G. J. Hinde described some Corals and Polyzoa from Western Australia; Dr. J. W. Gregory on fossil *Madreporaria* and *Millestroma* from Egypt. H. A. Nicholson and Robert Etheridge, jun., figured a small coral, *Cladochonus*, parasitic on the stems of crinoids.

Stromatopora.—Dr. Alexander Brown, working in the Aberdeen University laboratory, made a most important contribution on the structure and affinities of the genus *Solenopora*, and described and figured seven new species.

Starfishes (Asteroidea and Ophiuroidea).—H. Woodward announced a new and very interesting fossil Ophiuroid from the Silurian of Dudley named *Eucladia Johnsoni*; and *Helianthaster filiciformis*, another new species of starfish from the Devonian of South Devon. Dr. P. Hebert Carpenter figured and noticed a group of beautiful bulbous-armed starfishes from the Chalk of Bromley, Kent. A paper

was contributed by the late Dr. Wright on a new *Ophiurella nereidea* from Calciferous Grit, near Weymouth. The Rev. J. F. Blake noticed a new Solaster (*S. Murchisoni*) from the Lias, Yorkshire, closely resembling *Solaster moretonis*; and Dr. J. W. Gregory wrote on *Lindstromaster antiqua* and *Palæasterina Bonneyi* from the Ludlow beds of Shropshire, and *Protaster brisingoides* from Victoria, Australia.

Crinoidea. — G. E. Roberts communicated a note on the Mountain Limestone of Yorkshire and its Crinoids, and gave an excellent chromo-lithographic plate of *Woodocrinus expansus*, found near Richmond. J. Rofe monographed five genera of Crinoids from the Mountain Limestone of Lancashire and Yorkshire, giving a plate illustrating the structure of these forms; he also noticed the curious swellings on stems of Crinoids due to small investing Corals, known as *Cladochonus*, which he described (1869). Ten years afterwards Nicholson and Etheridge redescribed this coral. Mr. Rofe had a further paper on the minute structure observable in the column of *Pentacrinus*, illustrated by excellent figures, and in yet another paper he described the structure in the stems of *Rhodocrinus*, *Platycrinus*, and *Eurycrinus*. Professor G. de Koninck gives an account of new and remarkable Echinoderms from British Palæozoic rocks, figuring the genera *Palæchinus*, *Placocystites*, and *Haplocrinus*. E. Billings called attention to *Placocystites* = *Ateleocystites Huxleyi*, from Dudley, while H. Woodward added a note and figures of the same, and in 1880 more fully discussed and figured this remarkable Cystidean. J. E. Lee noted the occurrence of *Cupressocrinus* in the Devonian Limestone near Kingsteignton. Dr. F. A. Bather figured *Merocrinus Salopiæ* from the Ordovician of Shropshire, *Hapalocrinus Victoriæ*, a new Silurian Crinoid from Melbourne, Victoria; he added studies in Edrioasteroidea, and gave an account of his search for *Uintacrinus* in England and Westphalia.

Echinoidea.—Professor P. Martin Duncan had a note on *Galerites albogalerus*, Lamk. Dr. J. W. Gregory described *Rhyncopygus Woodi* from the English Pliocene, and some Australian fossil Echinoderms, *Archæodiadema*, a new genus of Liassic Echinoidea, and Egyptian fossil Echinoderms. T. Roberts noticed two abnormal Cretaceous Echinoids from the Lower Chalk of Cambridge.

Annelida. — J. Hopkinson figured *Dexolites gracilis*, a new Silurian Annelid from Moffat; H. A. Nicholson, two new species of Tubicular Annelids; and R. Etheridge, jun., wrote on British Carboniferous Annelida and noticed some 25 species (1880).

Crustacea.—The Crustacea have always occupied a very important position in the pages of the Geological Magazine. Sir J. William Dawson described and figured *Homalonotus Dawsoni* from the Upper Silurian, Pictou, and *Anthrapalæmon Hilliana* from the Carboniferous of South Joggins, Nova Scotia. C. Spence Bate figured *Archæastacus Willemœsii* (which is really equivalent to *Eryon crassichelis*) from the Lias of Lyme Regis. James Carter refers to *Orithopsis Bonneyi* from the Upper Greensand of Charmouth, near Lyme Regis, Dorset; and notices fossil Isopods from the

Upper Greensand of Cambridge. Professor T. T. Groom gave figures and descriptions of a minute Trilobite, *Acanthopleurella Grindrodi*, from the Dictyonema shales (Cambrian) of Malvern. Professor C. E. Beecher sent (1900) a restoration of the great long-legged Eurypterid, *Stylonurus Lacoanus*, from the Devonian of Pennsylvania, U.S. Professor G. A. J. Cole noticed *Belinurus kiltorkensis* from Ireland; and Dr. Anton Fritsch described *Prolimulus Woodwardi* from the Permian 'Gaskohle' of Bohemia. R. Etheridge, jun., noticed a *Turrilepas* from the Upper Silurian of New South Wales, and Professor W. B. Benham figured a gigantic form of Cirripede (*Pollicipes Aucklandicus*) from the Tertiary beds of New Zealand. Wyatt-Edgell described and figured *Lichas patriarchus* from the Llandeilo Flags, also *Asaphus Corndensis* and other species of Trilobites in a second paper (1867). Thomas Belt in two papers illustrated several new Trilobites of the genera *Olenus*, *Agnostus*, and *Conocoryphe*, from the Cambrian of North Wales. Professor Lapworth announced the discovery of the *Olenellus* fauna in the Lower Cambrian rocks of Britain, and described *Olenellus Callavei* from Shropshire. Professor Claypole recorded *Dalmanites* in the Lower Carboniferous of Ohio, U.S. Professor C. D. Walcott and C. E. Beecher sent three papers on the appendages and structure of Trilobites; and W. K. Spencer wrote on the hypostomic eyes of *Bronteus*. S. H. Reynolds figured *Dindymene Hughesiæ* and three other Trilobites, from the Lower Palæozoic of Wharfe, Yorkshire. F. R. Cowper Reed contributed eleven papers on Trilobites from the Cambrian, Silurian, and Carboniferous, including *Oryctocephalus Reynoldsi* from the Cambrian of North America. He noticed a new species of *Cyclus* (*C. Woodwardi*) from the Carboniferous of Settle, Yorkshire. Henry Woodward in six papers described and figured numerous species of Carboniferous and Culm Trilobites from Yorkshire and Devonshire. Two papers are devoted to *Homalonotus*, and six papers to Cambrian and Silurian Trilobites from Australia, Canada, and Britain. Of Brachyuran Decapod Crustaceans Dr. Woodward has monographed *Goniocypoda Edwardsi*, a new genus of shore-crab from the Lower Eocene of Hampshire; several species of crabs from the Upper Cretaceous of Faxe, Denmark, and from the Cretaceous of Vancouver Island, British Columbia; *Prosopon mammillatum*, a true crab from the Great Oolite of Stonesfield. Of Macrouran forms he wrote on *Scyllaridia Belli*, on two species of *Palæmon* from the Eocene of the Isle of Wight, and on *Meyeria Willetti* from the Chalk of Sussex. Dr. Woodward wrote seven papers on *Præatya scabra*, *Eryon antiquus*, *E. Stoddarti*, *Glyphea*, and *Penæus*, and on two species of *Æger*, all from the Lias formation of Dorset and Warwickshire, and on the genus *Anthrapalæmon* from the Coal-measures.

On fossil Isopods H. Woodward added three papers, one on *Palæga Carteri* from the Grey Chalk of Bedfordshire and Folkestone, and *Cyclosphæroma* from the Great Oolite of Northampton and the Purbeck beds of Aylesbury; ten species of the genus *Cyclus* from the Carboniferous Limestone and the Lower Coal-measures are defined

in three papers (1870, 1893, and 1894). The Cirripede originally described by H. Woodward (in 1868) as *Pyrgoma cretacea*, from the Chalk of Norwich, proved to be intermediate between the sessile and pedunculated groups. This new form, named *Brachylepas cretacea*, was discovered by Dr. Rowe, and described and figured by H. Woodward in 1901 (p. 145). Two species of *Turrilepas* from the Silurian are enumerated by the same author, one from Canada and one from Dudley. The gastric teeth and shields of Carboniferous, Devonian, and Silurian Phyllopods, especially of the genera *Dithyrocaris* and *Ceratiocaris*, received attention and description in five well-illustrated papers by the same author; while eight papers were devoted to the description and figuring of various genera of Merostomata, *Eurypterus*, *Stylonurus*, *Hemiaspis*, and *Neolimulus*, the last-named being the earliest king-crab known, coming from the Upper Silurian of Lanarkshire.

Entomostraca.—Mr. Sherborn and Mr. Chapman had papers on the Ostracoda of the Gault of Folkestone and the Tithonian of Nesselsdorf. Fourteen papers on Tertiary, Cretaceous, Wealden, Carboniferous, and Silurian Ostracoda from North and South America, South Africa, and Britain, have been contributed by Professor T. Rupert Jones. Four others, in conjunction with J. W. Kirkby and one with Mr. Sherborn, treat of the same subject. Professor Rupert Jones had also five papers on fossil *Estheriæ* from North America, South Africa, and Siberia; and eight papers in conjunction with H. Woodward on fossil Phyllopoda from the Palæozoic rocks. Messrs. Brady and Crosskey described in 1871 Post-Tertiary Ostracoda from Canada and New England; and Miss Partridge described *Echinocaris Whidbornei* and *E. Sloliensis* from Devonshire.

Insecta.—It is pleasant again to record the name of Professor John Phillips (1866), who, under the title of "Oxford Fossils," figured a dragon-fly's wing as *Libellula Westwoodi*, from the Stonesfield Slate, and compared it with the wing of *Æschna Brodiei* from the Lias of Dumbleton. J. W. Kirkby figured some insect-remains (part of wing of a species of *Blatta* and part of wing of an Orthopterous insect related to the Phasmidæ) from the Coal-measures of Durham. A. G. Butler illustrated the wing of a fossil butterfly from the Stonesfield Slate (1873), *Palæontina oolitica*, to which he again referred (in 1874), maintaining its Lepidopterous character against the opinion of S. H. Scudder, who considered it to be an Homopterous wing allied to the Cicada. S. H. Scudder described and figured a *tinted* Neuropterous insect-wing (*Brodia priscotincta*) from the Dudley Coalfield, and two other Carboniferous insects, *Archæoptilus* and *Ædæophasma*, from Lancashire. He added some notes on European species of *Etoblattina*, of which he enumerated 28 species (1896), also a new form, *E. Deanensis*, from the Forest of Dean, and gave an account of the Insect fauna of the Miocene of Oeningen, of which 876 had been described by Professor O. Heer and five figured by Scudder (1895). His earliest paper (not illustrated) was in 1868, on the fossil insects of North America (published by special request of Sir Charles Lyell). In 1867

Sir J. W. Dawson wrote upon, and S. H. Scudder gave diagnoses of, an insect-wing from the Coal-shale of Cape Breton, and four insect-remains from the Devonian of St. John's, Brunswick. In 1874 A. H. Swinton figured a fossil Orthopter of the genus *Gryllacris* (= *Corydalis Brongniarti*, Buck.) from Coalbrookdale. Charles Brongniart described (1879) a new genus of Phasmidæ (*Protophasma Dumasii*) from the Coal-measures of Commentry, Central France, and (in 1885) described various insects from the Primary rocks. H. A. Allen described (1901) *Fouquea cambrensis* (near to *Lithomantis*) from the Coal-measures of South Wales. The Rev. P. B. Brodie (1893) noticed the Eocene Tertiary Insects of Gurnet Bay, Isle of Wight, collected by A'Court Smith. Henry Woodward (1884) described the wing of a Neuropterous insect from the Cretaceous Limestone, Flinders River, North Queensland. He discoursed on British Carboniferous cockroaches and on their larval forms (*Etoblattina Peachii*), etc. (1887, pp. 49 and 431). He also described a Neuropterous insect (*Palæotermes Ellisii*) from the Lower Lias, Barrow-on-Soar, in which the clouded colour of the wing had been preserved in the fossil (1892).

Arachnida.—Henry Woodward described in 1871 a remarkably perfect Arachnid, *Eophrynus Prestvici*, from the Coal-measures near Dudley, preserved in a nodule of clay ironstone. He also figured *Architarbus subovalis* from the Coal-measures of Lancashire in 1872. R. I. Pocock redescribed *Eophrynus* and figured two new Arachnids, from the Coal-measures.

Myriopoda.—Henry Woodward illustrated some remarkable spined Myriapods from the Carboniferous rocks of England and Scotland.

(*To be continued.*)

II.—On the Relations of the 'Writing Chalk' of Tullstorp (Sweden) to the Drift Deposits, with reference to the 'Interglacial' question.

By Nils Olof Holst.[1]

In the district of Tullstorp in Scania (Southern Sweden) the white 'Writing Chalk' is dug rather extensively, and in exploring the ground numerous borings have lately been made which have shown that this Chalk is not actually in place as supposed by Angelin, B. Lundgren, J. Jönsson, J. C. Moberg, W. Dames, and others, but occurs only in extraordinarily large

[1] Dr. N. O. Holst's researches in Greenland on the Inland Ice and his views on Post-Glacial earth-movements in Scandinavia are already well known to English readers. The recently published paper of this eminent Swedish geologist, "Om skrifkritan i Tullstorpstrakten och de båda moräner, i hvilka den är inbäddad: ett inlägg i Interglacialfrågan" (*Sveriges Geol. Undersökning: Afhandlingar och uppsatser*, ser. C, No. 194, 1903), is of such general interest to all glacial geologists, that I have been glad to have had the privilege of rendering some little assistance to the author in his preparation of this English abstract of his paper. The doubts as to the validity of the evidence for even a single Interglacial Period, which have been expressed recently in several countries, are here put forward with great force, and it is clear that a general re-discussion of this very important question is rapidly becoming imperative.—G. W. Lamplugh.

transported masses or boulders (*Schollen*), up to 850 metres long, 300 metres broad, and 15 metres thick, which are embedded in the glacial deposits.

The true bed-rock of the district is the 'Saltholms Limestone,' i.e. a Chalk newer than the 'Writing Chalk.' The 'Saltholms Limestone' is not reached at a less depth than 33 to 70 metres, while the 'Writing Chalk' is met with at a couple of metres below the surface.

The transported masses of 'Writing Chalk' seem at first glance to be almost intact and undisturbed. But when more closely examined, they are found to be crushed and to form a brecciated chalk; and further, it is seen that the flint-bands are ground to pieces, that the thin clayey partings of the Chalk are slightly contorted, and that the moraines (boulder-clay) and the glacial gravels are sporadically carried down and sometimes squeezed into the Chalk to a considerable depth. Still more remarkable is the occurrence of portions of the antlers of *Cervus elaphus*, which are occasionally found entirely isolated in this Chalk; in one case, a piece of antler of this kind was found at a depth of 6 metres from the surface of the 'Writing Chalk.'

The transported masses of the 'Writing Chalk' rest upon the 'lower moraine' ('lower boulder-clay'). In a few instances they are also covered by this moraine, but as a rule their covering consists of the 'upper moraine' ('upper boulder-clay') and fluvio-glacial deposits.

The phenomena in the Tullstorp district have been compared by the author with the much discussed phenomena of similar character at Moen, Rügen, and Finkenwalde, and with the numerous transported masses or 'Schollen' which are found at so many places among the glacial deposits of Northern Germany. The resemblance between the mode of occurrence of these masses and that of the displaced '*Cyprina*-clay' has also been discussed, and for several reasons, partly borrowed from the well-known paper of Johnstrup on this deposit, the author has concluded that the '*Cyprina*-clay' is decidedly pre-Glacial.

The bearing of these facts as an argument against the hypothesis of an Interglacial Period will now be summarized.

The 'Writing Chalk' of Tullstorp occurs under the same conditions as many of the so-called 'Interglacial' deposits, i.e. between the two moraines (boulder-clays). But if we are to regard these morainic deposits as two separate ground-moraines belonging to two distinct Glacial episodes, there would be no good reason for refusing to assign the 'Writing Chalk' to an 'Interglacial' period, along with the other so-called 'Interglacial' beds which occur under the same conditions. The author holds, however, that only the 'lower moraine' is true ground-moraine, and that the 'upper moraine' consists of material which was originally incorporated in the ice-sheet as 'internal moraine' and was set free on the melting of its lower part. Indeed, the two moraines are so dissimilar in character that if, as is generally acknowledged, the lower deposit is a ground-moraine, the upper must have had a different origin.

The differences between the two moraines have elsewhere been fully discussed by the author. He has himself observed in Greenland that, whereas the lower or 'ground'-moraine is characterized by its rounded, often striated stones, and its clayey matrix of a bluish-grey colour, the upper or 'internal' moraine, on the other hand, is characterized by its more angular, rarely striated stones, its looser, more gravelly texture, and its weathered aspect due to oxidization during the melting of the ice. And the same difference exists between the two moraines in Germany and Sweden also. In the latter country this difference is just as conspicuous in the northern districts as in the country at the outer margin of the Scandinavian ice-sheet. The chief conclusions to be drawn from this difference may be recapitulated under the following five heads :—

1. As a rule, both in Germany and in Sweden, the thickness of the 'upper moraine' is too small and too uniform to represent a separate ice-age, being sometimes a couple of metres, sometimes 3 to 4 metres, and only exceptionally attaining a slightly greater thickness.

2. The 'upper moraine' enwraps the uneven contours of the underlying deposits, even when these are loose gravels and occur in abrupt ridges and mounds, so that the 'upper moraine' often reflects rather closely the contours of its underlying floor. No ground-moraine can behave in this manner.

3. The 'upper moraine' is less compressed and less coherent than the ground-moraine, because no ice-sheet has passed over it. It contains few stones, and not rarely has a more or less definite stratification, which shows that it has to some extent been acted upon by 'water of melting' (*Schmelzwasser*) during its deposition. The few striated stones which it contains have probably been derived from the 'lower moraine.'

This distinction has frequently been laid stress upon by other authors. James Geikie remarks upon it as follows: "One may note in many cases that the till which overlies interglacial deposits is not infrequently a somewhat looser clay than the generally excessively tough lower till that clings to the rocks underneath. Often, too, the stones and boulders of the overlying till are, as a whole, less well smoothed and striated than those in the boulder-clay below." The latter deposit he calls "unstratified" and the upper "indistinctly bedded."

This conspicuous difference also induced Johnstrup to regard the 'upper moraine' as having been formed in a special way, viz., by drifting or floe ice.

4. If the 'upper moraine' had been a separate and distinct ground-moraine originating from a separate ice-sheet, it ought to possess a definite outer limit marking the greatest extension of this ice-sheet. Such a limit has certainly been diligently sought, but it has never been found and will never be found, because it has never existed.

One of the most striking features in glacial geology is the great terminal moraine of the European ice-sheet, but its importance has

been obscured by the idea of an 'Interglacial' period (*Interglazialismus*), which has diverted the attention of most observers chiefly to the two moraines, with the supposition that these have originated at widely different times.

5. If the 'upper moraine' had represented a separate ice-age, preceded by a long Interglacial epoch with an ameliorated climate, it ought to contain abundant vegetable remains. Plentiful traces of forest-growth should, in this case, have been found embedded in the moraine, for this 'upper' drift, unlike the 'lower moraine,' is not thick enough to bury and conceal the débris of any land-surface that might have existed outside the ice.

The stratified deposits of sand and gravel which lie between the two boulder-clays are most readily explicable as being, from the beginning, of intermorainic origin. In many cases they have probably been formed in ice-dammed water-filled basins over which the thin border of the ice-sheet was buoyed up, thus allowing the subglacial streams to deposit their sand and gravel below the ice which contained the internal 'upper' morainic material.

To this series of deposits belongs also the Rixdorf Sand. The great extent and thickness of the latter, as well as the manner of its stratification (sand alternating with coarse gravel and shingle, frequently showing conspicuous false bedding), clearly indicate that this deposit is glacial; for what streams could deposit such thick beds, including coarse gravel and shingle, on a plain, except under Glacial conditions! The fauna of the Rixdorf Sand is a mixed fauna; the fossils are exclusively, or at least principally, found in the coarse gravel, and must be derivative. This opinion regarding the Rixdorf Sand is maintained also by W. Wolff and G. Müller (*Protokoll der Januarsitzung*, 1902, *der Deutsch. Geol. Gesellsch.*).

Thus, in the opinion of the writer, the evidence tells strongly against the idea of an Interglacial Period. The crux of the matter lies in the correct interpretation of the two moraines. It has been shown that these belong to one and the same period of glaciation; and it is further held that the so-called 'Interglacial' deposits themselves, when correctly interpreted, afford confirmatory evidence to the argument against the 'Interglacial' hypothesis.

III.—The Fingers of Pterodactyls.

By Professor S. W. Williston, University of Chicago.

As is well known, all pterodactyls have three small, unguiculate fingers on the radial side of the patagial finger, evidently used in the support of the body, possibly also in prehension and ambulation. In the older forms these fingers were relatively much better developed than in the later ones, the metacarpals of the former, of considerable strength, all articulating with the carpus, whereas in the more specialized forms of later geological age the proximal ends of these bones had become either greatly attenuated or entirely lost. In *Nyctosaurus*, for instance, the very small anterior metacarpals were not more than one-eighth of the length of the wing-metacarpal,

and were in life loosely attached by the soft parts only to the distal part of that bone.

Recently, in the examination of a specimen of *Pteranodon* or *Ornithostoma*, in which all the bones of the hand had been preserved in nearly their original positions, I have observed that these three small fingers have two phalanges in the first, three in the second, and four in the third, the terminal one of each a much curved and sharp claw. So far as I can learn, all known pterodactyls have the same number and arrangement of these bones. In any event, I believe that any possible variation will be found in a lessened rather than an increased number. Seeley ("Dragons of the Air," p. 129) confirms this arrangement of the phalanges in these animals. The patagial finger has, as is well known, four phalanges, probably in all known forms. It seems very probable, however, that in the evolution of this finger for the support of the volant membrane, the original clawed phalange had become lost, not that it had become greatly elongated as the fourth phalange. More especially does this seem probable from the fact that in the later, more specialized forms of these animals there is a marked tendency toward an increase in length of the proximal membrane-supporting bones, and a shortening of the distal ones. In a specimen of *Rhamporhynchus*, as stated by Seeley (op. cit.), the first wing-phalange measured 3½ inches in length, while the fourth phalange had a length of 2 inches. In a specimen of *Pteranodon* now before me the proximal wing-phalange measures nearly 27 inches, while the fourth is only a little over 5 inches in length. A still greater disproportion exists between the fingers in *Rhamphorhynchus* and *Nyctosaurus*. Now, if my reasoning is correct, the phalanges in the four definitely known fingers of pterodactyls originally numbered, in succession from the radial to the ulnar side, 2, 3, 4, 5. It is well known that in all reptiles, save the turtles, the anomodonts, and certain extinct hyperphalangic forms, as well as in the birds, this phalangeal formula applies to the first four digits of both the hands and the feet, and it certainly does to the feet of pterodactyls. The conclusion, therefore, seems to me incontestable that the wing-finger of pterodactyls is the fourth, as was formerly held by all writers on these animals. In 1878, however, Oscar Fraas suggested that the so-called pteroid bone really represented the first finger, and that the wing-finger is the fifth. This view was adopted by both Marsh and Zittel, and is the one now universally accepted by palæontologists.

It therefore seems evident that the 'pteroid' is not a vestigial, abnormally reflexed metacarpal or phalange of the first digit, but an entirely distinct ossification. Just what this ossification is, it may be premature to suggest, but there is nothing unreasonable in the supposition that it is a carpal or sesamoid. This conclusion seems more probable from the fact that it was progressively developed in the later, more specialized forms reaching its maximum in *Nyctosaurus*, thereby subserving some progressively increasing functional use, which would hardly be expected were it a reflexed finger.

IV.—Notes on the Cephalopoda belonging to the Strachey Collection from the Himalaya. Part I: Jurassic.

By G. C. Crick, Assoc. R.S.M., F.G.S., of the British Museum (Natural History).

In 1851 Captain (now Sir) Richard Strachey[1] communicated to the Geological Society of London a paper "On the Geology of Part of the Himalaya Mountains and Tibet," based upon the observations which he had made during the years 1848 and 1849. The Palæozoic and Secondary fossils therein mentioned were described in 1865 by J. W. Salter and H. F. Blanford respectively in a work of which the title-page reads as follows: "Palæontology of Niti in the Northern Himalaya: being descriptions and figures of the Palæozoic and Secondary Fossils collected by Colonel Richard Strachey, R.E. Descriptions by J. W. Salter, F.G.S., A.L.S., and H. F. Blanford, A.R.S.M., F.G.S. Reprinted with slight corrections for private circulation from Colonel Strachey's forthcoming work[2] on the Physical Geography of the Northern Himalaya. Calcutta: O. T. Cutter, Military Orphan Press. March, 1865."

On p. 2 of this work Salter says: "The [Strachey] collection was brought home numbered and catalogued, but still required months of patient work in breaking up and chiselling out the specimens. When finally arranged upon tablets, with localities, he [Colonel Strachey] placed them all in the colonial collections of the Museum of Practical Geology, and left me the more pleasant task of comparing and describing them"; and in a footnote on p. 80 Salter adds that "all the figured specimens of Colonel Strachey's collection have been liberally presented by that gentleman to the Museum of Practical Geology, London." In 1880 the foreign collections (and among them the Strachey Collection) were transferred from that Museum to the British Museum. As many of the figured specimens were not marked as such, and having regard to the importance of this collection and in view of the interest which is now being manifested in the sedimentary deposits of the Himalaya, it seemed desirable that the collection should be carefully examined and the described and figured specimens identified and marked. The following notes are based on an examination of the collection as it now exists in the National Museum. The present part refers only to the Jurassic Cephalopoda; these were described by Professor H. F. Blanford in the work already mentioned (pp. 74–88 and 105–111). The systematic position of the species has not been discussed; this is being done by Professor V. Uhlig, of Vienna, who is preparing from a much larger amount of material a memoir on the fauna for publication in the *Palæontologia Indica*.

In Salter & Blanford's work on the "Palæontology of Niti," the plates are numbered from i to xxiii and are all marked vol. ii; of these the first nine are photographs of engraved plates, whilst the rest (x–xxiii) were lithographed and printed in Calcutta. As

[1] Quart. Journ. Geol. Soc., vol. vii (1851), pp. 292–310.

[2] This work was never published.

I have stated elsewhere,[1] besides a complete copy of the work, the library of the Geological Department of the British Museum contains a set of plates presented by Sir Richard Strachey in 1892. The first nine are engraved, and it is evident that it was from precisely similar imprints that the photographs issued with the work were taken; plates x–xiii, xvi–xviii, and xxi–xxiii were drawn and lithographed by W. H. Baily, the others, xix and xx, by C. R. Bone; and they were all printed by Ford & West, evidently in England. The two sets of plates present, in the drawing of the specimens, sufficient differences to show that the 'English' set was not copied from the 'Indian,' but that most of the figures at any rate were re-drawn from the actual specimens, additional details being given in several instances.[2] General Sir Richard Strachey informs me that the 'English' set of plates has never been "formally published," so far as he knows, "certainly not in England." The additional details given in this set of drawings has assisted in the identification of some of the figured specimens.

The majority, and probably the whole, of the figures are reversed. Some of them have been so much restored that the identification of the originals is attended with great difficulty. That they did not entirely meet with the approval of Professor Blanford is evident from Salter's remark at the end of the author's descriptions (p. 88) that reads as follows: "Since this was in type the figures have been corrected (as far as the state of the lithographic stones would allow) in conformity with Professor Blanford's instructions.—J. W. S."

In the first volume of his work entitled "Illustrations of Indian Zoology; chiefly selected from the collection of Major-General Hardwicke," published in 1830–32, J. E. Gray figured on plate c four figures of three species of Ammonites which he named *Amm. Nepaulensis* (figs. 1, 2), *A. Wallichii* (fig. 3), and *A. tenuistriata* (fig. 4). According to the legend on the plate, which is stated to have been "published [in] 1829," they all came from "Sulgranees, Nepaul."[3] Three of these specimens, viz., the originals of figs. 1, 3, and 4, are in the British Museum collection [No. C. 5052 = *A. Nepaulensis*; C. 5041 = *A. Wallichii*; and C. 5051 = *A. tenuistriata*], but the fourth, viz. the original of fig. 2 (*A. Nepaulensis*),

[1] G. C. Crick: Proc. Malac. Soc., vol. v, part 4 (April, 1903), p. 286.

[2] Compare, for example, in the two sets, pl. xi, figs. 1*c*, 2*c*; pl. xiii, fig. 1*a*; pl. xv, fig. 1*a*; pl. xvi, figs. 1*a*, 2*a*; pl. xvii, figs. 2*a*, *b*; pl. xxi, fig. 1*b*.

[3] Respecting the locality of these Ammonites Dr. W. T. Blanford, who was for many years connected with the Geological Survey of India, writes (Proc. Malac. Soc., vol. v, No. 6, October, 1903, p. 345):—"So far as I am aware, no such place as 'Sulgranees' is known, and I may add that it is very doubtful whether the Ammonites represented in the 'Illustrations' came originally from Nepal at all; it is more probable they were brought from further west, from the region whence Ammonites have been supplied to India in all probability for ages. It is certain that there has long been an importation of small Ammonites into India from the Tibetan side of the Himalayas, chiefly from the Spiti district, N.N.E. of Simla, or from the neighbourhood of the Niti pass, north of Kumaun. These Ammonites, together with certain other stones, are known to Hindus by the name of 'Saligram.' I think it is probable that this name, slightly modified and written *Sulgranees*, has been mistaken for the locality of the fossils."

I have not been able to trace. The example of *A. Wallichii* can be easily recognized as the figured specimen; and, although some of the matrix has been removed from the examples of *A. Nepaulensis* and *A. tenuistriata* since Gray's figures were drawn, there is abundant evidence as to the identity also of these specimens.

I have already shown elsewhere that Blanford refigured Gray's types of *A. Wallichii* and *A. tenuistriata* (in part) in pl. xv, figs. 1*a–c*, and pl. xv, figs. 2*b*, *c*, respectively. I also considered Gray's type of *A. Nepaulensis* (fig. 1) to have been refigured by Blanford in pl. xiv, figs. 1*a*, *b*, but quite recently I have seen the original of Blanford's figure in the Museum of the Geological Society of London (R. 10,116).[1] Professor Blake thought it possible that this was Gray's figured specimen, but such is not the case. The Geological Society's collection also contains the original of Professor Blanford's pl. x, fig. 7 (*Belemnites sulcatus*).

In the following notes the species are arranged in the order in which they were described in the "Palæontology of Niti," pp. 74–88.

1. Belemnites sulcatus, J. S. Miller.

(H. F. Blanford, in J. W. Salter & H. F. Blanford: Palæont. Niti, 1865, p. 76, pl. x, figs. 1–8.)

Of the eight figured specimens seven are now in the National collection. These are the originals of figs. 1–6 [Nos. C. 2566–C. 2571][2] and of fig. 8 [No. C. 2572]. They are accompanied by a Jermyn Street Museum label bearing the inscription "Oolitic: Niti Pass. Belemnites sulcatus. Stra. Him. Pl. 10. Pres. by Col. Strachey." The original of fig. 6 [No. C. 2571] is marked in ink "L" with a cross; the specimen represented in fig. 3 [No. C. 2568] is numbered in ink "1015"[3]; the original of fig. 5 [No. C. 2570] is numbered "1691" in a similar manner, and each of the originals of fig. 1 [No. C. 2566], fig. 2 [No. C. 2567], and fig. 4 [No. C. 2569] is similarly numbered "1692." The original of fig. 8 [No. C. 2572] is numbered in ink "1720"; it has been broken across and shows a subcentral siphuncle; it does not exhibit any depression near the margin such as is indicated in the figure. It seems, therefore, to be referable to the genus *Orthoceras*, and is most probably of Triassic age. This age of the specimen is supported by its lithological character, which agrees with that of the example of *Orthoceras pulchellum*—a Triassic species—represented in pl. viii, fig. 10*b*.

The specimen depicted in fig. 7 is now in the Museum of the Geological Society of London[4] (R. 10,252).

[1] See Professor J. F. Blake, "List of the Types and Figured Specimens in the Collection of the Geological Society of London," 1902, pp. 34 and 55.

[2] The numbers in square brackets refer to the Registers in the Geological Department, British Museum (Natural History).

[3] From a comparison with the Silurian Cephalopoda in the Strachey Collection it is quite evident that these numbers refer to Colonel Strachey's Catalogue of Localities referred to by Salter on p. 4 at the end of his description of *Asaphus emodi*.

[4] The specimen is duly recorded in Professor Blake's "List of the Types and Figured Specimens in the Geological Society of London," 1902, p. 55.

Besides these seven specimens five fragments were also transferred from the Museum of Practical Geology as part of the Strachey Collection. They are accompanied by a Jermyn Street Museum label bearing the inscription "Oolite: Niti Pass. Belemnites sulcatus, var. canaliculatus. Stra. Him. Pl. 10. Pres. by Col. Strachey," and are now numbered C. 2565*a*–*e*. Only two of these have any original ink-marks on them; the specimen No. C. 2565*c* is numbered "1015," like the original of fig. 3, and the example No. C. 2565*b* is marked "Laptet." The "L" of the word Laptet is in the same handwriting as, and precisely like, the "L" on the specimen represented in fig. 6 [No. C. 2571]. It is therefore possible that the "L" on that specimen may stand for "Laptet."

On p. 106 of the "Palæontology of Niti," H. F. Blanford puts Oppel's *Belemnites Gerardi* as a synonym of the present species, for which he retains Miller's name *B. sulcatus*, this claiming priority of publication.

With regard to the dimensions of the specimens Professor Blanford says: "The largest specimen in Colonel Strachey's collection measures as follows:—length, 3·6 in.; antero-posterior diameter, 0·9 in.; transverse diameter, 0·9 in." There appears to be some mistake here, because the largest guard at present in the collection, the original of fig. 1, has the following dimensions:—length, 126·5 mm. (nearly 5 inches); antero-posterior diameter, 30 mm. (1·2 in.); transverse diameter, 28 mm. (about 1·1 in.). The specimen represented in fig. 2 is nearly of the same size, its measurements being:—length, 115 mm. (4·5 in.); antero-posterior diameter (at about 30 mm. from the anterior end), 27 mm. (1·05 in.); transverse diameter (at same place), 27 mm. (1·05 in.).

2. Ammonites alatus (R. Strachey MS.), H. F. Blanford.

(H. F. Blanford, in J. W. Salter & H. F. Blanford: Palæont. Niti, 1865, p. 76, pl. xviii, figs. 3*a*, *b*.)

Of this species three fragments belonging to the Strachey Collection are now in the British Museum. Two of these [Nos. C. 7364*a* and *b*] are accompanied by a Jermyn Street Museum label bearing the inscription "Oolitic. Niti Pass. Ammonites alatus. Coll. by Col. Strachey," but they are not numbered in ink like many of the Strachey specimens. With them there is a guttapercha squeeze of the example numbered C. 7364*a*. To the third specimen [No. C. 7365], which is numbered "1834" in ink, there is attached a label bearing the words "alatus. Spiti Shales" written in pencil.

One specimen [No. C. 7364*b*] is merely the impression of the half of one side of a shell; the other two [No. C. 7364*a* and No. 7365] are evidently "the two fragmentary casts" from which was "compiled" the "restoration" that is represented in Blanford's pl. xviii, fig. 3*a*. There is no specimen in the collection which can be identified with Blanford's fig. 3*b*, the original of which possibly furnished the dimensions given by the author.

Although two of the specimens [Nos. C. 7364*a* and *b*] are labelled "Niti Pass" and the third [No. C. 7365] merely "Spiti Shales," yet the matrix and mode of preservation of the specimens are such as to lead one to believe that they all came from the same locality.

3. Ammonites Nepaulensis, J. E. Gray.

(*A. Nepaulensis* [sic], J. E. Gray: Illustr. Indian Zool., vol. i, 1830–1832, pl. c, figs. 1 and 2. *A. Nepalensis* [sic], H. F. Blanford, in J. W. Salter & H. F. Blanford: Palæont. Niti, 1865, pl. xiv, figs. 1*a*, *b*.)

There are two examples of this species in the National collection [Nos. C. 5052 and C. 7687].

One [No. C. 5052] is undoubtedly one of the specimens figured by Gray (op. cit., pl. c, fig. 1).[1] It is accompanied by a label belonging to the Museum of Practical Geology bearing the inscription "Oolitic; Niti Pass. Ammonites Nepalensis. Coll. by Col. Strachey." This is certainly an error; it could not have been collected by Colonel Strachey, because the specimen was figured in 1830–32 by Gray, whereas Colonel Strachey's specimens were not obtained until the years 1848 and 1849.[2]

The fossil is imbedded in a nodule, the greater part of one side only of the specimen being exposed. Since Gray's figure was drawn an attempt has been made to develop the fossil. A little more of the anterior part of the outer whorl has been uncovered, and some matrix has been removed in front of the aperture so as to display the commencement of the outer whorl, but only a little piece of this —a length of 12 or 13 mm.—has been successfully exposed close to the aperture. The surface of the rest of the first third of the outer whorl that was covered by matrix when Gray's figure was drawn has been injured during development. A small piece of the penultimate whorl bearing five principal ribs has been uncovered immediately beneath the aperture. The ribbing is well preserved over a little more than half of the outer whorl; it is very regular, and there are eighteen principal ribs in the last half-whorl. Notwithstanding the attempt at development there is no difficulty whatever in recognizing the fossil as the original of Gray's fig. 1. A specimen in the Museum of the Geological Society of London (R. 10,116) is thought possibly to be Gray's type (fig. 1), but an examination of the fossil clearly shows that such is not the case.[3] The dimensions of the exserted portion of the fossil, as nearly as can be measured, are:—diameter of shell, 101 mm.; height of outer whorl, 46·5 mm.; thickness of outer whorl, estimated at about 37 mm.; width of umbilicus, 23 mm.

The other specimen in the Museum collection [No. C. 7687] bears a label on which is written in pencil simply the name "*A. nepalensis*"; there is no other information with the specimen,

[1] G. C. Crick: Proc. Malac. Soc., vol. v, pt. 4 (April, 1903), p. 285.

[2] Quart. Journ. Geol. Soc., vol. vii (1851), p. 294.

[3] See Professor J. F. Blake's "List of the Types and Figured Specimens in the Collection of the Geological Society of London," 1902, p. 34.

but from its lithological character there can be no doubt whatever that it came from the Himalaya; it forms part of a nodule, like so many of the Niti fossils. It is 91 mm. in diameter.

I have not been able to recognize in the collection the original of Gray's pl. c, fig. 2.

I have elsewhere expressed the opinion that the original of Gray's fig. 1 was also the original of Blanford's pl. xiv, figs. 1*a*, *b*,[1] but this statement is incorrect, the original of Blanford's figures being in the Museum of the Geological Society of London (R. 10,116).[2] Blanford's figure is reversed. Both sides of the fossil are free from matrix, and well preserved, the side opposite to that which is figured being the better preserved of the two. On the figured side the surface of the first third of the outer whorl has been injured just as in the example figured by Gray; this was evidently the septate part; no septa are visible on the remaining two-thirds of the whorl, which therefore most probably constituted the body-chamber. The inner whorls, though incomplete, are better preserved than in Gray's type-specimen. There is a slight irregularity in the ribbing of the outer whorl, but not nearly so much as is indicated in the figure; on the side of the specimen opposite to that which is figured there are 33 or 34 principal ribs in the outer whorl, nineteen of these being in the last half-whorl. The measurements given by Professor Blanford are as follows:—diameter, 4·8 inches [= 122 mm.]; diameter [or height] of outer whorl, 2·2 inches [= 56 mm.]; thickness, 1·9 inches [= 48·5 mm.]. My own measurements of the fossil are:—diameter, 121 mm.; height of outer whorl, 55 mm.; height of outer whorl above preceding, 38·5 mm.; thickness of outer whorl, 48 mm.; width of umbilicus, 29 mm.

4. Ammonites tenuistriatus, J. E. Gray.

(*A. tenuistriata*, J. E. Gray: Illustr. Indian Zool., vol. i, 1830–1832, pl. c, fig. 4.
A. tenuistriatus, J. E. Gray: H. F. Blanford, in J. W. Salter & H. F. Blanford, Palæont. Niti, 1865, p. 78 [pl. xiv, fig. 2 ?], pl. xv, figs. 2*a–c*.)

The British Museum collection contains Gray's type-specimen [No. C. 5051]. It is accompanied by a label belonging to the Museum of Practical Geology bearing the following inscription: "Oolitic; Niti Pass. Ammonites tenuistriatus. Coll. by Col. Strachey (belongs to Brit. Mus.)," but the statement that it belonged to the Strachey Collection is obviously incorrect, for, as we have already stated in regard to *A. Nepaulensis*, Gray's figures were published many years before Colonel Strachey's specimens were collected. Although some of the matrix has been removed since Gray's figure was drawn, there are still indications on the fossil of the original extent of the matrix, and there can be no doubt whatever about its being the figured specimen. I have already shown elsewhere[3] that a portion of this specimen in its present condition formed the original of Professor Blanford's pl. xv, figs. 2*b*, *c*.

[1] G. C. Crick: Proc. Malac. Soc., vol. v, pt. 4 (April, 1903), pp. 286–7.

[2] Professor J. F. Blake: "List of the Types and Figured Specimens in the Collection of the Geological Society of London," 1902, p. 34.

[3] G. C. Crick: Proc. Malac. Soc., vol. v, pt. 4 (April, 1903), pp. 288–9.

The National collection also contains the original of pl. xiv, fig. 2 [No. C. 5039] and the natural mould [No. C. 5036] from which the guttapercha impression figured in pl. xv, fig. 2*a* was taken; both specimens belonged to the Strachey Collection, and were transferred from the Museum of Practical Geology in 1880. Their exact locality is not recorded; they probably came from the Niti Pass, because this is the only locality given by Salter & Blanford in their "List of the Himalayan Oolitic Fossils from the Niti and Spiti Passes" (p. 102). The specimen No. C. 5039 was accompanied by a label bearing simply the name "*Amm. Jubar*, Strachey."

5. Ammonites umbo (R. Strachey MS.), H. F. Blanford.

(H. F. Blanford, in J. W. Salter & H. F. Blanford: Palæont. Niti, 1865, p. 78, pl. xvii, figs. 2*a–d*.)

Professor Blanford states that "the only specimen in the [Strachey] collection is a fragment of the whorl represented two-thirds of the real size." The fragment is now in the British Museum collection [C. 5040]; it was transferred from the Museum of Practical Geology, labelled "Oolitic. Niti Pass. Ammonites umbo (Stra.). Coll. by Col. Strachey." It is numbered in ink "1690." It is entirely septate: the suture-line is well shown, but is very difficult to follow; its details are not quite correctly represented in the figure (2*d*). The suture-lines are not indicated in the figure in the 'Indian' set of the plates of Salter & Blanford's work, but in the 'English' set they are distinctly represented.

The measurements of the specimen, taken at about its centre, are as follows:—height of whorl, 1·5 in. or 38 mm.; width of ditto, excluding nodes, 1·9 in. or 48 mm.; width of ditto, including nodes, 2·25 in. or 57 mm. The dimensions given by Blanford are:—diameter [=height] of whorl, 1·7 in.; thickness [or width], 2·1 in.

On p. 106 Blanford places this species, as well as Oppel's *A. Seideli*,[1] as a synonym of the species *A. Hyphaspis*, which he himself described in 1863.[2]

6. Ammonites guttatus (R. Strachey MS.), H. F. Blanford.

(H. F. Blanford, in J. W. Salter & H. F. Blanford: Palæont. Niti, 1865, p. 79, pl. xiii, fig. 2.)

The example that was in the Strachey Collection is described by Professor Blanford as "an imperfect external cast of one side of a shell." This specimen is now in the British Museum collection [No. C. 7358], having been transferred in 1880 as part of the Strachey Collection from the Museum of Practical Geology. It was labelled "Oolitic. Niti Pass. Ammonites guttatus. Coll. by Col. Strachey." The figure given in the "Palæontology of Niti" is a somewhat restored, and very unsatisfactory, representation of a cast taken from this natural mould; its unsatisfactory character was recognized by the author, who states that "the restoration herewith given at Plate 13, fig. 2, is . . . . erroneous, the diameter

[1] Pal. Mittheil., 1863, p. 283, pl. lxxx, figs. 3*a*, *b*.
[2] Journ. Asiatic Soc. Bengal, vol. xxxii, No. 2 (1863), p. 132, pl. iv, figs. 2, 2*a*, 2*b*.

of the whorls being probably at least half as much again as they are represented, while from each tubercle springs a bundle of 4 or 5 ribs, which cross the ventral region with a slight convex curve towards the mouth."

Owing to the imperfection of the external part of the outer whorl it is impossible to give accurate dimensions of the specimen.

This species was first described in 1863 by Professor Blanford,[1] who regarded Oppel's *Ammonites Cautleyi*[2] as a synonym.[3]

7. Ammonites biplex, J. Sowerby.

(H. F. Blanford, in J. W. Salter & H. F. Blanford: Palæont. Niti, 1865, p. 79, pl. xi, figs. 1*a–c*; pl. xii, figs. 1*a–c*.)

Professor Blanford says:—"Two specimens of this Ammonite occur in the collection, together with some impressions of the shell on black siliceous nodules. I can detect no difference between them and the characteristic Oxford clay specimens of Europe. They are identical also in all respects (mineral character included) with those from Spiti, lately described by myself, from Dr. Gerard's collection."

From the Museum of Practical Geology were transferred two specimens [Nos. C. 5033 and C. 5034] belonging to the Strachey Collection, labelled, with one of that Museum's labels, "Oolitic. Niti Pass. Ammonites biplex. Coll. by Col. Strachey"; and two fragments [Nos. C. 7683*a*, *b*] accompanied by a label, "A. biplex. Spiti Shales," but it is not recorded how these were obtained.

To one of the two Strachey specimens [No. C. 5033] is attached another M.P.G. label, on which is written in ink simply the name "Ammonites biplex." This is evidently the original of pl. xi, fig. 1*a*, the figure being reversed and considerably restored; its anterior end, however, does not exhibit a septal surface such as is shown in fig. 1*b*, nor is its suture-line visible; it cannot, therefore, have formed the originals of the figures 1*b*, *c*. Nor are these characters displayed on the other specimen [C. 5034] in the Strachey Collection. This is numbered in ink "1032*a*," and it also bears a small square white label, originally bearing the number "24," but this has been crossed out and the number "1032*a*" substituted. There is no specimen in the collection agreeing with figs. 1*a–c* of pl. xii. Perhaps fig. 1*a* is in part a restoration of the example No. C. 5034, but this is far from certain.

The larger of the two fragments from the "Spiti Shales" exhibits the suture-line somewhat indistinctly, but I do not think it could have furnished the drawing of the suture-line given either in pl. xi, fig. 1*c* or pl. xii, fig. 1*c*.

8. Ammonites triplicatus, J. Sowerby.

(H. F. Blanford, in J. W. Salter & H. F. Blanford: Palæont. Niti, 1865, p. 80, pl. xiii, figs. 1*a–c*.)

Professor Blanford says:—"This Ammonite is only distinguished

[1] Journ. As. Soc. Bengal, vol. xxxii, No. 2 (1863), p. 131, pl. iv, figs. 1, 1*a*, 1*b*. According to F. Stoliczka, the type-specimen "is deposited in the Asiatic Society's collection, Calcutta" (Mem. Geol. Surv. India, vol. v, 1866, p. 104, footnote).

[2] Pal. Mittheil., iv (1863), p. 279, pl. lxxviii, figs. 1*a*, *b*, 2*a*, *b*.

[3] Palæont. Niti, 1865, p. 106.

from the preceding by the fasciculate character of the ribs in adult specimens, young shells of the two species being undistinguishable."

Two specimens are represented on pl. xiii. Figs. 1*a*, *b* are the lateral and front views (reversed and somewhat restored) of the specimen in the British Museum collection bearing the register number C. 5042. This fossil was transferred from the Museum of Practical Geology, but there is neither one of that Museum's labels nor any other original label with it, nor can I see any numbers written upon the fossil. But its agreement with Blanford's figure cannot be doubted for a moment. The author gave no dimensions of the fossil. The measurements are:—diameter of shell, 85 mm.; height of outer whorl, 28 mm.; thickness of outer whorl, 31 mm.; width of umbilicus, 37·5 mm. The sutures are not shown.

Fig. 1*c* has been drawn from a guttapercha cast of a natural mould; both the cast and the natural mould are in the national collection [Nos. C. 5031 and 5031*a*]. They were transferred from the Museum of Practical Geology, and are accompanied by one of that Museum's labels as follows:—"Oolitic: Niti Pass. Ammonites biplex (Sow.). Coll. by Col. Strachey." This was written in ink, but the word "biplex" has been crossed out in pencil, and above it has been written in pencil the name "triplicatus." The fossil is clearly the original of Blanford's figure, but this represents only a part of the specimen, and has been somewhat restored.

9. Ammonites torquatus, J. de C. Sowerby.

(H. F. Blanford, in J. W. Salter & H. F. Blanford: Paleont. Niti, 1865, p. 80, no fig.)

Professor Blanford's observations on this species are as follows:—

"The only character by which I can distinguish this species from *A. biplex*, Sow., are:—Its thicker and more depressed whorls, and a slight notching of the ribs above the siphuncle. These characters are exhibited by the typical Cutch specimens, as well as by those in Colonel Strachey's cabinet, and also by the specimens described and figured by me, in the Spiti collection of Dr. Gerard. The distinctness of the notching and the depression of the whorls vary, however, in different specimens, and a more extensive comparison is requisite to decide whether *A. torquatus* be really distinct from *A. biplex*.

"Mr. Sowerby, in his description of the figured specimens from Cutch, states that they are distinct from 'a Himalayan species,' in having an 'incurved inner margin.' On comparison of the specimens, I can, however, detect no such difference, nor, indeed, any other than that the Himalayan specimens have uniformly more numerous (about 55) ribs than those from Cutch, which have about 45."

Among the specimens which were transferred from the Museum of Practical Geology as the Strachey Collection there are four examples [Nos. C. 7676*a*–*d*] labelled "Oolitic: Niti Pass. Ammonites torquatus (Sow.). Coll. by Col. Strachey"; of these, three have the broad whorls characteristic of *A. torquatus*, whilst the fourth has somewhat more compressed and more finely ornamented whorls

and is certainly specifically distinct. The largest specimen [No. C. 7676*a*], a broad-whorled form, has scratched upon it the locality "Lakur." Its dimensions are :—diameter of shell, 59·5 mm. ; height of outer whorl, 18·5 mm. ; thickness of outer whorl, 31 mm. ; width of umbilicus, 25·5 mm. The largest specimen but one is a little better preserved, with sharper and somewhat coarser ornaments, but is not such a broad-whorled form as will be seen from its dimensions, which are :—diameter of shell, 57·5 mm. ; height of outer whorl, 17·5 mm. ; thickness of outer whorl, 26·5 mm. ; width of umbilicus, 27·5 mm.

(*To be continued.*)

V.—Stevn's Klint.

By the Rev. E. Hill, M.A., F.G.S.

THE fine cliff of Stevn's Klint on the Danish coast is seldom mentioned in English geological writings. As it presents a clean section several miles long of the uppermost Danish Chalk, and is easily visited in a day's excursion from Copenhagen, a short sketch may have some interest for readers of this Magazine. It has none of the astonishing scenery displayed by the coasts of Möen and Rügen : the land is level and bare, the cliff is not broken and not wooded : yet it possesses a prettiness of its own.

A railway running south from Kjöge, a town south-west of Copenhagen, forks at Haarlev : the western branch leads to the famous inland quarry of Fakse,[1] the eastern to a coast hamlet called Rödvig. The Chalk in the cliff here is only a few feet high, but it rises in the eastward direction and may be followed along its edge for the full length. Or the train may be left at Storre Hedinge, a little town with a respectable hotel, whence four miles of road lead to the cliff at Höjerup, where the section is most accessible.

The ancient church here stands on the cliff, closer to the edge than those at Dunwich or Sidestrand, and, unlike those, in full use still. Guidebooks print a local legend that it would have fallen long ago but that every Christmas night it shifts itself a handsbreadth (*hanefjed*, a cock's step) inland, to remain as before uninjured on the brink.

The country traversed from Storre Hedinge is level, almost without undulation, to the cliff edge. The cliff section shows this to be the upper surface of Glacial Drift, here a somewhat earthy or silty clay, containing stones and occasional boulders up to a foot across. Clean sections are not very frequent. In these, as elsewhere in Baltic Drifts, there is sometimes an appearance of divisions; e.g., about 1 or 1½ miles north of the Lighthouse I noted (in descending order) : red earthy clay, 3 feet ; light-brown, dry, cracked clay, with chalk and large boulders, 4 feet or more ; pale chalky clay, tougher and less cracked, with more stones and flints, and with a boulder

[1] Commonly, but wrongly, Faxoe. See Geol. Mag., 1901, p. 486.

at its base, 8 feet or more; then chalk: the line between the second and third members is sharp. One object of my visit was to examine whether any disturbances in the Chalk had affected overlying beds. At Höjerup the upper surface of the Chalk is irregular, somewhat following the wavings of certain flint bands in it. There was a good section of a drift-filled hollow, where the drift showed an appearance of two members with streaks like bedding near the division. These streaks did not bend down into the hollow. If they marked beds, I concluded that here was a hollow filled by subsequent deposition, not Chalk with drift bent conjointly. The evidence would probably not have convinced a leader of opposition, but it will presently be seen that debate is silenced by a 'previous question.'

The Drift lies on an irregular surface of a white limestone, a rock which nothing I have seen in England represents or resembles. Nothing represents it, for here are the very highest beds of the Danish Chalk. Nothing resembles it, for we see white limestone seamed with bands of grey flint. Not flints, but flint (or ought I to say chert?) in solid continuous sheets. The flint is as continuous as the thicker sheets of white limestone which it divides. The flint bands may reach as much as 8 inches in thickness, and at Höjerup there may be six or eight in about 25 or 30 feet vertical. Elsewhere they are often further apart and, I think, fewer. Their colour varies from light to dark grey. The limestone resembles clunch in colour and texture. It is extensively worked all along the cliff for building material. It is sawn on the spot into rectangular blocks, which are hoisted up to the cliff edge and carted inland for cottages and farm buildings.

The flint bands in the limestone do not lie horizontal or straight. They undulate gently: I estimated one arc to have 50 feet of chord to 10 feet of vertical height (what when we studied Newton's "Principia" we were taught to call Sagitta). While considering these undulations I gradually became aware that they were not always parallel. The wavy bands were not identically bowed and wavy; the intervals between them thickened and thinned; here and there a band forked or died out. I had always supposed that flint beds marked original horizontal surfaces of deposition, but here were surfaces which hardly could have been all originally horizontal. Flint sometimes fills cracks and joints. I began to speculate on bowed surfaces of yielding to stress; segregation of silica along bending lines of weakness. But this would throw doubt on many conclusions, and undermine some theories, perhaps some of my own as well as others. While so "revolving sweet and bitter thoughts" my eye fell on a guidebook remark—"Geologists regard the Fakse Chalk as a coral-reef." Stevn's Klint is only some fifteen miles from Fakse. So, after all, these waving layers, I suppose, do indicate surfaces of an old sea-floor, but an uneven one.

I find that Ussing ("Danmark's Geologi," p. 82) regards only a few inches near the base as representing the proper Fakse beds. He designates the 30 or 40 feet above as Limsten, and considers

this a deep-water deposit; though in earlier days Forchhammer had attributed the irregularity to shallowness and nearness to land. The series as a whole is designated the Newer Chalk.

At the base of this Newer Chalk I noticed a few inches of brecciated rock, possibly the part said to represent the Fakse beds. All below is often hid by a talus-slope, some thirty or forty feet high. Where this has been cleared away there is exposed also chalk, but a different chalk. It is softer, whiter, and shows lines of flints (flints, not flint; the black nodules with white skins that we know so well in our cliffs of Albion). It is designated by the Danish geologists Writing Chalk (*Skrivekalk*, translating the German *Schreibekalk*). The boundary between it and the overlying Newer Chalk is straight, and the lines of flints in it are straight also. This disposes of the question, mooted above, as to the origin of a drift-filled hollow. It shows that such hollow cannot be due to bending, for the Writing Chalk is not bent. My hope of evidence on the question whether the Drift has been affected by movements in underlying beds was destroyed. The chalk, however, has been slightly moved. A distant view of a long stretch of cliff, south of Höjerup, seemed to show a straight junction-line between the two chalks, with a straight line of flints in the lower, which rose northwards, approximating to the junction-line. (This would indicate some interval of time between the two.) Also, the top of the Writing Chalk, which at Höjerup is perhaps 30 feet above sea-level, some three miles north, at Eskesti, has risen to the top of the cliff, about 80 feet high. Though the Newer Chalk is absent there, it again caps the cliff a little further north, at Mandhoved Pynt, 120 feet high, the highest ground of the cliff. At Eskesti is an extensive quarry in which the straight parallel lines of flints are numerous and conspicuous.

This lower Writing Chalk yields to the sea-waves, and leaves the Newer Chalk overhanging it as a great cornice along most of the cliff. In consequence the beach can seldom be reached except by aid of ladders. In five or six miles of cliff there were only five or six spots where I found paths continuous down to the sea. The waste, however, must be slow, as the legend quoted above will show. Signs of landslip were rare. Even gullies in the cliff edge were shallow and short; only one ran 100 yards inland. The contrast between this level platform and the broken surfaces of Möen and Rügen was as great as that of Rügen's steeply dipping flint lines or Möen's contorted and shattered strata with these even, regular beds. The three localities have, however, much in common. They are all Chalk mantled with Drift; they all face east; they all stand out into the Baltic, lofty bastions against its assault.

The level strata of this cliff suggest one important reflection. Stevn's Klint presents vertical faces, sometimes over 100 feet high, to the south, east, and north. I saw the greater part, and saw no dislocation or disturbance of beds. Not twenty miles off, across the sea, is the mainland of Sweden. Where were these cliffs when a Northern Ice-sheet advanced? Or, what was the Northern Ice-sheet

when it advanced against these cliffs? Were the cliffs then safe beneath the sea? Or, was the ice-sheet accommodating and pliable? The beds are undisturbed. "Facts bein' stubborn and not easy drove," says Mrs. Gamp. Was Stevn's Klint stubborn? At any rate, it is a fact.

A Tongue of Glacial Clay.

At Rödvig, on the west side of its little port, the top of the Stevn's Klint Chalk is only about eight feet above sea-level. Over it lies eight or ten feet of Glacial Clay. The line between Chalk and Clay was clean and clear, roughly but not perfectly level. At one spot a tongue of clay ran into the chalk, about twelve feet long, not more than three inches at its thickest. Such tongues are often to be seen at such junctions, but this attracted my attention. The cliff faced south; the point of the tongue was on my right hand, and its connection with the mass of clay on the left; the tongue therefore entered the chalk from the west. Any ice-sheet at this spot may have been moving from north or east, but no one would imagine a movement from the west. The tongue was not thrust in by an ice-sheet.

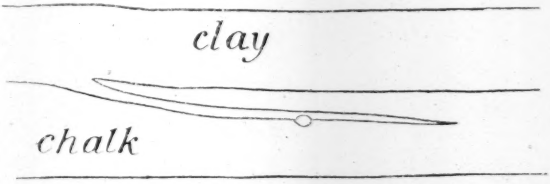

FIG. 1.—Tongue of Clay in Chalk.

In the clay of this tongue were two or three flints; one, pear-shaped with a narrow stem-end, had this narrow end imbedded in the lower surface of the chalk, while its thicker part extended nearly, but not quite, to the top of the clay. It was *in sitû*, but any thrust would have displaced it. So this clay had not been introduced by thrust, neither had any horizontal pressure acted on the flint. The fissure filled with clay may have been made by solution of water percolating along a crack, or by repeated freezing and expanding of water in such a crack, or by some lifting of an attached cake of ice; but certainly by no horizontal force.

FIG. 2.—Middle portion of above, enlarged.

[*Figures represent tracing of diagrams in notebook made on the spot.*]

It may be worth while to notice carefully such tongues elsewhere, in case some of them may afford evidences of their causes. Here the Danish Clay seems to have put out its tongue against a Baltic Glacier.

Recent Ice-Transport.

The following extract from a sixpenny Danish Tourist's Guide to Kjöge and Stevn's Klint seems worth reproducing:—[Near Vemmetofte] "in the shore-wood there lies some distance from the water a vast block, called Musestenen, as large as a labourer's hut; in the severe winter of 1895 this was carried by the ice several hundred alen (*al*, about two feet) away from the water, inland."

REVIEWS.

I.—Round Kanchenjunga, a Narrative of Mountain Travel and Exploration. By Douglas W. Freshfield; with an Appendix on the Geology, etc., by Professor Garwood, F.G.S. pp. xvi and 367; 42 illustrations and 3 maps. (London: Edwin Arnold, publisher to H.M. India Office, 1903. Price 19*s*. nett.)

THE somewhat restricted territory of Sikhim, lying as it does between the native Himalayan States of Nepal and Bhotan, is yet extensive enough to enable the European traveller to penetrate into the heart of the mountainous region of the eastern Himalayas, which is dominated by the stupendous mass of Kanchenjunga. The most ordinary globe-trotter nowadays can take his trip to Darjiling and there enjoy the world-famed view of the monarch of the Sikhim mountains. Nay, more, from a point in the neighbourhood easily accessible he may, under favourable circumstances, obtain a telescopic view of the still mysterious Everest group, which the jealousy of the Khatmandu Government is reserving, perhaps, for the mountain-climbers of the middle of the twentieth century.

Returning, however, to the subject of Kanchenjunga, it is one thing to admire a mountain, and another thing to go round it, as did Messrs. Freshfield, Garwood, and the Sellas, during the early Autumn of 1899. Mr. Freshfield is a mountaineer and traveller of great experience, and he states emphatically his conviction that nowhere else on the earth's surface can there be found, within so small a radius, a combination of tropical luxuriance, sylvan beauty, and mountain sublimity equal to that which meets the traveller's eyes among the valleys and highlands of Sikhim and Eastern Nepal. It is small wonder, therefore, that such a country should have attracted a certain amount of notice from previous writers. Of these he principally mentions two, viz. Sir J. D. Hooker and Major Waddell, both of whom have contributed largely, with pen and pencil, to the description of this wonderful region. There is probably no one interested in 'earth-science' who has not at some time of his life read with delight "Hooker's Himalayan Journals," written in the middle of the nineteenth century. With good reason has the author of the present work thought fit to dedicate it to "The pioneer of mountain travel in the eastern Himalayas," whose graphic pages and characteristic illustrations are by no means superseded even at the present day, whilst in the comparative

facility with which he could at that time travel in eastern Nepal he enjoyed advantages denied to more recent explorers.

In the present case photography has largely contributed to the value of "Round Kanchenjunga," and for most of these illustrations the author is indebted to Signor Vittorio Sella, who had previously proved his skill as a mountain photographer in the Alps, in the Caucasus, and in Alaska. Prints of the original photographs have already been in the hands of the public, and some of the illustrations have appeared in scientific periodicals. As regards maps, Mr. Freshfield complains of the inadequate delineation of the glaciers of Kanchenjunga. "Even Sir Joseph Hooker," he says, "had not approached near enough to it to explore its glaciers, which had consequently never been described by any competent hand; while many of them had never been visited by Englishmen. In the sheets of official surveys they had been alternately ignored and caricatured. There was no map in existence which even pretended to show the snows and glaciers of the region on any system recognized in modern scientific surveys." Consequently we are presented with what Mr. Freshfield considers a glacier-map of Sikhim should be, and in the construction of this he has mainly been indebted to his companion Professor Garwood. This map is a well-executed piece of work, and we doubt not that it attains to a fair accuracy of detail in those glacier-basins which the travellers themselves explored.

So far as we are aware, no glacier region of the Himalayas has been more characteristically delineated, and certainly in the eastern Himalayas nothing approaching the execution of this glacier-map of Kanchenjunga has ever been attempted. The topography of this huge mountain-knot, the ridge and valley system, the crests that are crowned with perpetual snow, and the hollows that are filled with ever-moving ice, all are brought out in a way which should rejoice the chartographer. Roughly speaking, Kanchenjunga is a gigantic cross, where a north and south ridge intersects with an east and west ridge. The north summit of Kanchenjunga, 28,150 feet, results from the intersection of the northern *arête*, whose buttress may be taken as the Pyramid, 23,350 feet, with the very crooked western *arête*, whose buttress is the wonderful mountain Jannu, 25,300 feet. The southern summit of Kanchenjunga, 27,280 feet, distant rather less than a mile from its neighbour, results from the intersection of the southern *arête*, whose buttress is Kabru, 24,115 feet, with the eastern *arête*, whose buttress may be taken as Simvu, 22,300 feet; or, if we extend the point a little further to the eastward, we reach Siniolchum, 22,570 feet, a most picturesque mountain, which serves both Waddell and Freshfield for a frontispiece. In the hollows between these *arêtes* we have, on the east, the gigantic Zemu glacier, on the north-west the Kanchenjunga glacier, on the south-west the Yalung glacier, on the south-east the Talung glacier,—all four, not to speak of minor ice-flows, radiating from the central massif of Kanchenjunga.

The first attempt of the party to round the mountain was by way of the Zemu glacier, and they attained an elevation towards the

upper part of this immense *mer de glace*, which placed them face to face with its precipitous eastern cliffs. At that time it would seem that one of their possible objectives was to cross a depression in the northern *arête*, known as the Nepal gap, 21,000 feet, and so descend on the western or Nepal side. All these hopes were frustrated by an unprecedented snowstorm, and ultimately they had to make a long detour north-eastwards into the Lhonak valley, where the lines of the landscape are those of an ice-protected region. "The gentle, smooth surfaces of the lower slopes are obviously due to their long protection by snow and ice from the destructive agencies of air and water, and the rapid alternations of frost and heat that have carved out the loftier ridges and deeper valleys further south. It is a land of moraines, the monuments of departed or diminished glaciers. Their vast dykes stretch along the hillsides or cross the valleys, enclosing flats that were first glacier-basins and afterwards lake-basins." Further on he says of the Lhonak landscape: "The rock surfaces are protected by a coverlet of snow, formerly permanent, even now raised only for a few weeks in the year. The action of water is consequently insignificant. The process of valley formation is checked, and the hillsides are scored by no deep lateral ravines." This is a valuable lesson in rock erosion which geologists may gladly accept from so experienced a mountaineer as Mr. Freshfield.

After toilsome journeyings in this region the party began to approach the continuation of the northern ridge or *arête* of Kanchenjunga, taking to the ice once more at a considerable elevation, and gradually working their way upwards until they attained a height of 20,207 feet on the Jonsong La, on whose further side they had their first peep into Nepal. This was the supreme moment. It was doubtful if their native guide had ever been there before, whilst the prospect on the western side of the pass had all the appearance of an appalling *cul de sac*, whose possible outlet was completely concealed by the sinuosities of its containing walls. "Lasciate ogni speranza voi, che'ntrate" might well have been the feeling of some members of the expedition, but the stern determination of the leader prevailed, and down they all went into the abyss.

They were presently rewarded, however, by a view of the north-western face of Kanchenjunga, hitherto unseen by European eyes. "From this point of view," the author says, "as from all others, except the Guicha La, it appears as a colossal screen; but here, in place of gigantic rock precipices, it shows a snowy face." Continuing their descent, they obtained evidence that the gorge they were traversing had an opening into the lower world, and they ultimately encamped at an angle known as Pangperma, where they found themselves face to face with the glacier which descends directly from Kanchenjunga and joins the one by whose course they had come down. From this point was obtained the famous panoramic photograph which faces p. 172, and which may be regarded as a complete picture of the Kanchenjunga group as seen from the north-west. Continuing down the gorge of the Kangchen river, they passed from the U-shaped valley of ice erosion into the V-shaped valley of water

action, and finally reached the inhabited village of Khunza, where the party found themselves on Hooker's track of fifty years ago. Having thus far stolen a march on the Nepalese authorities, it was advisable to return into Sikhim as quickly as possible. This was effected by way of the Chunjerma pass, immortalized by Hooker in his famous view of Jannu, and finally by way of the Kang La, 16,313 feet, where they crossed the continuation of the southern ridge into territory under British protection. From Jongri they reconnoitred the southern approaches of Kanchenjunga.

Professor Garwood contributes an appendix on the geological structure and physical features of Sikhim, which country, he says, consists entirely of crystalline rocks for the most part of a uniform and commonplace type. But to the physical geographer and petrologist the country is rich in suggestive facts, whilst the theoretical problems raised must await a more detailed survey. He does full justice to the accuracy of Hooker's original observations, and refers to attempts which have been made by Sherwill and others to study the geology of the region. He has prepared what he calls "material for a geological map of Sikhim," which is, in fact, a good unshaded topographical map with the local geological features marked in red ink.

Limiting our remarks to the western side of the deep Teesta valley, and more especially to the neighbourhood of Kanchenjunga, we note the prevailing dips to be about east-north-east, the rocks denoted being mainly varieties of gneiss with some mica-schists and quartzites. Frequently it happens that the higher grounds present the smallest degree of inclination. Thus, on or near Jannu dips to the eastward of 5° and 10° are noted. The curious rock-tower on the summit of Jannu, judging from pictures, has almost the appearance of a horizontal sedimentary series, but since the actual nature of the rock is probably unknown the appearance taken for dip may be deceptive. Selecting another buttress of the central massif, viz. Kabru, this is marked as augen-gneiss dipping east-north-east 20°. The mighty precipices north-east of Kanchenjunga towards the head of the Zemu glacier are marked as "fine gneiss, intrusive sheets of white granite and pegmatite," dipping 5° to the westward. On the other hand, very high dips, approaching the vertical, are noted towards the termination of the Zemu glacier in rock described as "gneiss with pegmatite." This, of course, is in a comparatively low position; we likewise notice in the principal valley of Lhonak dips of 30° to the southwards in quartzose gneiss. Again, in the deep valleys of the Rangit river-system, between Darjiling and Jongri, are shown high dips in all directions, though not seldom to the westwards, in mica-schists and gneiss. In these crystalline rocks the observed dip is more or less an unknown quantity; nevertheless, in the sedimentary beds of portions of the north-west Himalayas the feature of high dips in the valleys and lower dips on the hill-tops is by no means uncommon.

The petrology of Kanchenjunga and its buttresses is made out partly by way of inference from boulders in the moraines, and

partly from observations *in sitû*. No one, we presume, has hitherto closely approached the actual throne of the monarch, which probably consists of fine white or grey granite in a setting of augen-gneiss, which latter is by far the most abundant rock variety throughout the immediate vicinity of this mountain mass. Of actual granite the indications are by no means numerous. During the descent of the Jonsong glacier the party had good opportunities for observing the northern precipices of Kanchenjunga. "In their lower portion, at all events, they appear to be formed of massive augen-gneiss penetrated by pegmatites, these being the only rocks found on the moraines of the Kanchenjunga glacier. Sometimes the gneiss is finer and contains hornblende, but this mineral is absent from the Kanchenjunga gneiss, and it is probable that the hornblende-bearing variety belongs to a different rock into which the augen-gneiss is intruded. This gneiss forms the cliffs of the Kangbachen and Khunza valleys, and is recorded by Hooker as occurring also further west in the Yangma valley as far north as he penetrated. The same rocks again appear to form the massive walls of Jannu, and to stretch south-east to Kabru and the Guicha La." This class of rock Professor Garwood regards as a foliated granite intrusion. Its composition is simple, consisting almost entirely of porphyritic eyes of white orthoclase embedded in a foliated matrix of biotite, quartz, and plagioclase felspar. Crystals of tourmaline, hornblende, and garnet are invariably absent from the typical augen rock, but are plentiful in the pegmatites associated with it.

There remains one more subject for consideration with reference to the geology of this region, viz. the absence of specifically recognizable fossils, although there are evidences of altered limestones in connection with the gneissic masses. Three distinct and widely separated localities are marked on the geological map as follows:—

(1) In the far north-east, near the Donkhya Pass and Cholamo Lake, where Hooker observed "fossil limestone, much foliated and faulted; blue pisolitic conglomerate; shale and iron pyrites, some crystalline with encrinites, and (?) nummulites too altered for determination." This is at an elevation of over 18,000 feet on the borders of Thibet.

(2) Still on the Thibetan frontier, near the Chortenima La, which has an elevation of 18,650 feet, and only a little to the north of the track to the Jonsong Pass, are "altered limestones with Crinoid stems; sandstone altered into quartzites, and tourmaline-calcite rocks." One might be inclined to believe that these are limestones of Carboniferous age which have undergone alteration from contact with an igneous mass. Supposing them to be Carboniferous and not Eocene limestones, their presence has no particular bearing on the age of this part of the Himalayan uplift, though there is no reason to suppose that such uplift is otherwise than Tertiary in date.

(3) On the western slopes of Pandim (22,020 feet) we find indicated on the map "metamorphic sedimentary rock, with intrusive pegmatites and hornblende gneiss." These appearances had already been described by Hooker from a distance as looking

like *a stratified series into which veins of igneous rock had been injected*—an inference much to the credit of his powers of observance, the more so since the feature seems to have escaped the notice of subsequent investigators. The rocks of this series show great variety in hand specimens, but two types predominate, one of which is of considerable mineralogical interest. Under the microscope this green-bedded rock is found to contain, in addition to garnet and epidote, a considerable quantity of scapolite and white augite, which latter is plentiful together with numerous crystals of sphene. "The abundance of scapolite in an undoubtedly altered calcareous shale is perhaps the most noteworthy feature of this rock." Thus we find that if this metamorphic series has so far contributed nothing organic which might throw any light on its age or origin, yet as a contact rock it produces a greater variety of minerals than the more massive gneisses which surround it.

The general conclusion to which Professor Garwood arrives is, that the bulk of the gneiss, and particularly the augen-gneiss, must be regarded as an igneous rock, and he is disposed to attribute the metamorphism of the sedimentary series directly to its intrusion. The evidence is in favour of the sedimentary series, in two cases at least, being of Palæozoic age, and he suggests that the gneiss was intruded as a huge laccolitic mass during the folding which accompanied the elevation of the range. Such a fan-like fold would help to account for the inverted dip of the beds towards the roots of the chain, a feature which seems to be in accordance with the inward dip of the foot-hills in parts of the north-west Himalayas.

W. H. H.

II.—The Evolution of Earth Structure, with a theory of geomorphic changes. By T. Mellard Reade, F.G.S., etc. pp. xv, 342, with forty plates. (London: Longmans, Green, & Co., 1903. Price 21*s.* net.)

THE volume before us may be taken as the sum and substance of the author's observations and conclusions with respect to the structure of the earth, the changes which the rocks have undergone, and the origin of the movements which have effected the earth's crust. While he claims that "Nearly the whole of the matter is original, and the greater part quite novel," it is understood that this applies to work that has extended over something like forty years, and that much has previously been printed in Journals and Proceedings of Scientific Societies, in his essay on "Chemical Denudation in relation to Geological Time" (1879), and in his volume on "The Origin of Mountain Ranges considered experimentally, structurally, dynamically, and in relation to their Geological History" (1886). This last work was reviewed by the Rev. Osmond Fisher in the Geological Magazine for 1887 (pp. 229–233).

The present work is divided into three 'books,' of which the first deals with geomorphic changes. The subject is illustrated by a useful diagram, drawn to scale, showing half the sphere; with

(1) its interior spheroid or nucleus, "considered by many physicists to be mainly iron," (2) a 500-mile zone or shell of igneous magma, and (3) the lithosphere, 30 miles thick. The ten-mile zone of elevation and depression is shown by a strong line; within it "all the denudations, depositions, depressions, and elevations of the surface of our planet take place." A diagram of this kind is always useful. We have one before us now, printed in 1851, by James Nasmyth. It represents an arc of a circle 64 feet in diameter on which are indicated the relative magnitude of several mountains, the deepest mine, and the probable mean elevation of dry land. Nasmyth rightly remarked that "In contemplating Geological Phenomena, nothing more directly aids the mind in arriving at correct conclusions than the useful practice of comparing the magnitude of all such phenomena to that of the Earth itself."

Mr. Mellard Reade starts with the recorded instances of elevation and depression, making special though brief reference to those of Pleistocene and later times, such as Raised beaches, Submerged forests, and 'Drowned valleys.' These in some cases may have been contemporaneous; the 40 ft. beach at Irvine, in Ayrshire, being linked with a 10 ft. beach in the Isle of Man, and with a depression on the shores of the Bristol Channel. In other cases the evidence of 'raised beaches,' which indicate a former submersion of four or five thousand feet, requires confirmation.

Admitting movements of 1,000 feet, the author proceeds to show that these oscillations of level cannot be due mainly to the shifting of weight by denudation and sedimentation, though such changes exert influence in combination with other agencies. He believes that the relative proportions of land and water have been fairly constant throughout the ages, and that regional changes of level are due to alterations in the bulk of certain portions of the lithosphere without movement in mass.

The researches of various observers on the diffusion of metals, the differentiation of igneous magmas, the effects of temperature and pressure, and the change of physical properties and of volume with changed conditions, show that "the conception of the earth simply as an *inert* mass cooling in space is a fallacious one."

In his "Origin of Mountain Ranges" the author maintained that as the volcanic pipes from which lava emissions proceed are probably in communication with the subterranean heated matter, there would necessarily be some mixture of material differing in constitution and thermal condition. Consequent upon internal changes, the volumes and specific gravities of the mineral masses of the lithosphere would be subject to increase and decrease over large sections of the globe. Increase of volume by expansion would lead to continental uplifts, while the 'deeps' of the ocean would be depressions below the true spheroid, due to the superior density and less volume of the underlying masses of the earth.

On the other hand, the expansions and contractions to which mountain-building is due "are mostly lateral and intermittent, creating creeps of the lithosphere and surface rocks, ending in the

folding and permanent ridging-up and corrugations of the earth's surface." These movements, it is held, may be initiated by a long course of sedimentation, causing a sinking of the sea-bed.

In connection with this subject the author points out that "a depression of the ocean bottom will draw the waters from the land and increase the land areas, while a rise of the sea-bed will cause a transgression of the oceanic water over the land." Here it may be remarked that in 1868 Mr. H. B. Medlicott observed that "The assumption of the absolute permanence of the sea-level (that its level has permanently maintained the same radial distance from the centre of the earth) has quietly taken the position almost of a postulate in geological induction. The notion is inconsistent with any progressionist doctrine, essentially so with Laplace's theory."[1] Mr. Mellard Reade, however, sees no evidence of enormous contraction of the earth's radius, although he observes that "in every known instance where proof is possible, the continents are at lower levels now with respect to the sea than they were on some former occasions during their lengthened history." The explanation given in these cases is that there has been a rise of portions of the floor of the ocean basins.

After referring to the persistence of certain lithologic characters in formations over wide areas, notably among the Carboniferous, Triassic, and Oolitic groups, the author remarks that the land areas grow by accretion from existing land, the ruins of former continents having added to their extent, and thereby securing the continuity of land areas throughout geologic time. That "New lands are the consequents of sedimentary loading and recurrent expansion" is a subject he dealt with in his "Origin of Mountain Ranges."

Turning to the sub-oceanic configuration, the author gives reasons for believing that the bed of the Atlantic is not a plain, "but a diversified surface like that of the dry land, and that a large portion of it has at some former geological age been carved out by sub-äerial agencies." These diversified contours lie beyond the continental shelves, which are mainly sedimentary.

In Book ii the author discusses the dynamics of mountain structure and experimental geology, a subject more fully treated in his work on the "Origin of Mountain Ranges." Herein he brings to bear his experience as an architect and engineer, and the practical experiments he has made combine to give weight to his conclusions. The results of experiments are depicted in numerous plates, illustrating compression, shearing, and contortion of various kinds. Microscopic sections of rocks are also given. The time has perhaps long passed when anyone would sympathize with Ramsay, who (in 1877), while A. Geikie and J. Clifton Ward were examining thin slices of rock under the microscope, exclaimed, "I cannot see of what use these slides can be to a field-man. I don't believe in looking at a mountain with a microscope."[2]

[1] Quart. Journ. Geol. Soc., vol. xxiv, p. 37.

[2] "Memoir of Sir A. C. Ramsay," by Sir A. Geikie, 1895, p. 343.

The author rightly seeks help from all quarters, and as a result of his deliberations he maintains that if a belt of rocks of varied character and some miles in thickness be subjected to fluctuating increases in temperature, then both vertical and horizontal expansion will ensue; but the principal forces will act horizontally. He points out the stresses and strains, the shearing, the faults and foldings, and the torsion-structure that would be produced by complex movements; and he observes that slaty cleavage is always accompanied by mineral changes in the body of the rock, which give the foliaceous character and supply the necessary cement to bind the overlapping constituent grains.

His experimental investigations lead to the belief that the forces affecting the earth's crust have been gradually applied, "that mountain ranges are built up by gradual and successive creeps, and that a sudden release of pent-up forces takes place on a scale not larger than what is experienced in a great earthquake."

Book iii comprises Reprints, Speculations, and Closing Remarks. Here the author refers to the supposed permanence of oceans and continents. While the very slowness of the processes has given practical permanency to the main features, yet "The conclusion is forced upon us that movements and interchanges of such magnitude have occurred in the distribution of the oceans and land masses during geologic time that it would be a misnomer to call them 'permanent' . . . . . the changes are essentially forms of development, the permanence is that of land connection."

The volume is not one which can be looked upon as eminently readable or popular, nor on the whole is the subject-matter well arranged; but it comprises a mass of valuable data and of conclusions based upon observation and experiment that cannot fail to be of service to every student of 'Geomorphology' and to aid materially in the elucidation of the subject.

III.—Recent Researches on the Scottish Carboniferous Rocks.

1.—On the distribution of fossil Fish-remains in the Carboniferous rocks of the Edinburgh district. By Ramsay H. Traquair, M.D., LL.D., F.R.S. Trans. Roy. Soc. Edin., vol. xl, pt. 3, pp. 687–707, with two plates (tables of strata).

2.—The Canonbie Coalfield: its geological structure and relations to the Carboniferous rocks of the north of England and central Scotland. By B. N. Peach, LL.D., F.R.S., and J. Horne, LL.D., F.R.S. Ibid., pt. 4, pp. 835–877, with four plates.

THE appointment in 1895 of a Committee of the British Association to inquire into the possibility of dividing the Carboniferous rocks of Britain into life-zones, and the special researches of Dr. Wheelton Hind on the mollusca, of Dr. Traquair on the fishes, and of Mr. Kidston and Mr. Newell Arber on the plants, have aroused exceptional interest in the subdivisions of the Carboniferous system, and in the correlation of these divisions in different areas. A great deal has been learned, and while the two papers before us

form substantial contributions to our knowledge, "there is abundance of room," as Dr. Traquair observes, for further investigation.

In dealing with the Carboniferous fish-remains of the Edinburgh district, Dr. Traquair remarks on the general similarity in the lithological characters and in the *facies* of the organic remains of the Scottish strata, which in mass are of estuarine origin. Elsewhere in Britain the Upper Carboniferous rocks are also mainly of 'estuarine' or 'lagoon' formation, but the Lower, except in the extreme north of England, are almost as exclusively marine in their origin; and in this grouping Dr. Traquair takes the Millstone Grit as the base of the Upper division. His researches, which have extended over a period of thirty years, show that in the Edinburgh district different assemblages of estuarine fishes characterize the two Carboniferous divisions. Indeed, it is remarkable that not one of the species from the Upper Carboniferous rocks "can safely be identified as occurring in the rocks below; we have evidently got into quite a new ichthyological stage."

Further, the Lower Carboniferous fish-remains found in the limestones of open-sea origin differ from those occurring in the estuarine beds, and belong to the marine fish-fauna characteristic of the Mountain Limestone of England and Ireland. Rarely is there any commingling of these types of fishes. At the same time the number of marine species is greater and of estuarine species less in the Lower Carboniferous series of Lanarkshire and Ayrshire, than in the rocks of the Lothians and Fifeshire.

Turning to the evidence obtained in other areas, Dr. Traquair points out that, whether in Northumberland, Yorkshire, or North Staffordshire, nearly all the common Upper Carboniferous estuarine fishes have a wide range in the Coal-measures, so that "it is not possible to divide these strata into ichthyological life-zones." Elsewhere also he finds a great difference between the species which occur below and above the Millstone Grit. "Only two species can with certainty be named as common to the two divisions, namely, *Callopristodus pectinatus* and *Acrolepis Hopkinsi*."

In the Scottish Millstone Grit no determinable fish-remains have been found, but among the fishes recorded by Mr. E. D. Wellburn from this division in Yorkshire and Lancashire, there are both Lower Carboniferous marine species and Upper Carboniferous estuarine species. The occurrence of the latter in the Millstone Grit coincides with the evidence of the plants, which according to Mr. Kidston "are entirely Upper Carboniferous in aspect." Dr. Traquair is thus led to ask, "Did the marine fish-fauna of the Carboniferous epoch change less rapidly than that of the estuaries and lagoons?"

The fact, however, remains that a great and wide-spread change took place in the fish-fauna at about the time of the Millstone Grit.

Dr. Traquair directs attention to a peculiar fish-fauna in the estuarine Lower Carboniferous beds of Eskdale. At Glencartholm, near Langholm, more than thirty species of fishes have been obtained, and of these only one, *Tristychius minor*, is found in the Lower

Carboniferous beds of Central Scotland. On this interesting point, which Dr. Traquair leaves unexplained, we turn to the later paper by Dr. Peach and Dr. Horne. These authors deal with the structure of the Canonbie Coalfield, which occupies a small tract between the Liddel Water and the river Esk in the south-eastern part of Dumfries-shire. They describe the Glencartholm shales as occurring in a volcanic group, above the Fell Sandstones, and probably below the horizon of the Scremerston coals of the eastern border counties. The shales form a rich palæontological zone, which was discovered by Mr. A. Macconochie, and found to contain a large number of new genera and species, including plants, brachiopods, lamellibranchs, cephalopods, scorpions, eurypterids, ostracods and other crustacea, as well as fishes. The zone has not elsewhere been detected, but some of the many species have been found in the Calciferous Sandstone group elsewhere in Scotland, and Dr. Peach is confident that other species will likewise be found away from the Canonbie district.

In their description of this district the authors begin with the Old Red Sandstone, which has yielded scales of *Holoptychius*; and they then give details of the strata and fossils of the Lower and Upper Carboniferous, the Millstone Grit being taken as the base of the Upper division. Workable coals occur at various horizons above the Glencartholm beds; and some estimates are given of the coal-supply in concealed portions of the area. The work is well illustrated by a coloured geological map and sections, and it contains an exhaustive account of what is known of the area from a scientific and practical point of view.

IV. — The Position of the Old Red Sandstone in the Geological Succession. By A. G. M. Thomson, F.G.S. 8vo; pp. vi, 224. (Dundee: John Leng & Co., 1903.)

THIS book is divided into five sections, but otherwise it has no headings, no illustrations, no details of sections, not even an index. The object of the author is to suggest "*certain hypotheses*, well supported by circumstantial evidence," and he proceeds to state that "These hypotheses, *in the first place*, are intended to shew that the conditions under which the Old Red Sandstone was produced may not have been of the character of inland lakes without free connection with the sea; and, *in the second place*, that the conditions which produced the Old Red Sandstone may not have begun only after the close of the conditions which produced the youngest of the Silurian beds, nor have terminated before the date of deposition of the oldest of the Carboniferous beds."

The entire work appears to us to be a case of much ado about nothing. There is not a single reference to any other published view, otherwise the author might have spared himself the long and laboured arguments to support hypotheses with which perhaps a good many geologists would be inclined to agree. He might at any rate have fortified himself with reference to Hypothesis No. 1 by quoting the Rev. W. S. Symonds, "Records of the Rocks," 1872.

p. 215, and Professor Hull, Quart. Journ. Geol. Soc., xxxviii, 205. With regard to his second Hypothesis, the passage between Silurian and Old Red Sandstone and between Old Red Sandstone and Carboniferous has been pointed out by numerous geologists, although the evidence of passage between Silurian and Old Red Sandstone in South Wales and Monmouthshire has not been confirmed by the recent work of the Geological Survey.

The author dwells a good deal on "the suddenness with which vertebrate life, in well-developed types, appears within the British area in the uppermost beds of the Silurian system," and in order to make clear his phraseology he adopts "the rather awkward specific terms of, respectively, 'Prevertebrate Silurian,' 'Vertebrate Silurian,' 'Prevertebrate Old Red,' and 'Vertebrate Old Red,' as also the generic terms 'Prevertebrate Palæozoic' and 'Vertebrate Palæozoic.'" He recognizes that certain "'Prevertebrate Old Red' fresh-water, or, at least, brackish-water estuarine areas were devoid of animal life," but maintains that some of these basal beds "were being formed when 'Prevertebrate Silurian' sediments were being laid down beyond the limits of the estuaries, and therefore under marine conditions." Here, as in other cases, we fail to find the precise evidence which would make the author's contentions of value, and we regret that we cannot recommend the work as likely to prove either attractive to our readers or of serious help to students. We can, in fact, only wonder why such a work has been published.

V.—Geological Rambles in East Yorkshire. By Thomas Sheppard, F.G.S., Curator of the Municipal Museum, Hull. 8vo; pp. xi, 235, with geological map and many illustrations. (London: A. Brown & Sons [1903].)

THERE are few districts that can offer so many attractions to the geologist and to the collector of fossils as that described in this volume. From Spurn Head to Redcar, a good deal beyond the limits of the geological map of the East Riding which accompanies this work, the author takes us in a series of rambles; and under his guidance we see and learn much about the Recent and Pleistocene deposits, the White and Red Chalk, the Speeton Clay, the many divisions of the Oolites, and the Lias of Robin Hood's Bay, Whitby, and Redcar. The information is imparted in a pleasant style, and is thoroughly 'up to date,' due regard being paid to the work of the geologists of old, to William Smith, Young and Bird, John Phillips and Leckenby (though we miss a reference to Martin Simpson), as well as to that of Judd, Tate and Blake, Hudleston, Fox-Strangways, Reid, Lamplugh, Kendall, Stather, and others. The author himself, too, has laboured with much enthusiasm on the geology of the newer deposits, and we can cordially recommend his book as a handy and reliable guide to this interesting region. The work is well illustrated, and mostly from photographs. There is a good index, but curiously enough no date is affixed to the volume.

REPORTS AND PROCEEDINGS.

I.—Geological Society of London.

I.—December 2nd, 1903.—Sir Archibald Geikie, D.C.L., D.Sc., Sec. R.S., Vice-President, in the Chair. The following communications were read:—

1. "Notes on the Garnet-bearing and Associated Rocks of the Borrowdale Volcanic Series." By the late Edward Eaton Walker, Esq., B.A., B.Sc. (Communicated by J. E. Marr, Esq., M.A., F.R.S., F.G.S.)

The first portion of the paper is occupied with an account of various intrusive rocks. A detailed description of sills and dykes of garnet-bearing rocks in the Langstrath Valley is given; and similar rocks are described occurring as dykes and sills around the Eskdale granite and the Buttermere granophyre, and also in the Armboth-Helvellyn area. These rocks vary in degree of acidity. They consist of diabase, porphyrite, and granophyre. Evidence of their characters being dependent upon differentiation accompanied by some absorption is offered. They appear to be related to the Eskdale and Buttermere masses of intrusive rocks.

The volcanic rocks are next considered. Garnets are found in the Falcon Crag Group, in a group of rocks below the great banded ashes and breccias of the Scawfell Group, and in the rocks of the Scawfell Group itself; but do not seem to occur, except as the result of contact-metamorphism, in the Eycott Group. The most interesting garnetiferous volcanic rocks are those which occur below the Scawfell ashes and breccias. These rocks often have a streaky structure which exhibits four distinct types: resulting from (*a*) infiltration along planes of weakness, (*b*) lamination of ash, (*c*) flow of igneous material, and (*d*) dynamic action on included fragments. The rocks are not intrusive, but consist of lavas and ashes, often exhibiting alternating bands of rhyolite and andesite.

The banded ashes of the Scawfell Group also contain garnets.

In the Haweswater district there is an intercalation of rocks of the Eycott type with rocks possessing the 'streaky' structure. This intercalation appears to be original, and not the result of subsequent earth-movements.

The garnets are of the almandine type. They often have a ring of felspar around them, which, when the intrusive rocks are studied, suggests that the mineral is original; but similar rings occur around garnets in the ashes, showing that the felspars may be formed in solid rock. In certain ashes of the Haweswater district, the existence of cavities in the garnets suggests a metamorphic origin for the mineral, but it is difficult to understand how the metamorphism has been produced.

The paper closes with a description of certain undoubted metamorphic changes.

2. "A Contribution to the Glacial Geology of Tasmania." By Professor J. Walter Gregory, D.Sc., F.R.S., F.G.S.

On reading the literature on the glaciation of Tasmania, the author came to the conclusion that, except for such traces of high-level glacial action as those of Mount Sedgwick recorded by E. J. Dunn and T. B. Moore, and those near the summit of Mount Ida recorded by Officer, Balfour, and Hogg, the evidence consisted of material that was either not of glacial origin or was due to glacial action at some upper Palæozoic date. After giving a detailed analysis of the previous contributions to this subject, the author describes the evidence obtained by himself personally in the northern portion of the island. The town of Gormanston stands on a glacial moraine of recent geological age, formed later than the excavation of the Linda Valley, and occurring as a bank projecting from the southern side of the valley and nearly damming it across. The moraine is composed of typical Boulder-clay, and behind it are bedded clays which probably accumulated in a glacier-lake above the moraine-dam. An erratic of fossiliferous limestone, 4½ by 3½ by 2½ feet, scratched all over and partly polished, is mentioned, while the North Lyell Railway has cut through an enormous boulder of black Carboniferous Limestone at least 16 feet in length. The northern face of Mount Owen appears to be ice-worn to the height of about 1900 feet, while the basis of the glacial deposits is not more than 700 feet above the sea. The general evidence suggests that the Eldon Range and the Central Plateau formed the gathering-ground of the ice which flowed westward and south-westward. A map is given to show the range of Pleistocene glaciation so far as it has been recorded, and also to indicate localities at the glacial deposition which probably dates from the Carboniferous Period. The lowest level at which evidence of Pleistocene glaciation has been found is 400 feet on the Pieman River. This latest glaciation is later than the formation of the peneplain of North-Western Tasmania, and occurred after the dissection of this peneplain had begun. Many of the deposits are little more altered than those of Northern England, despite the heavy rainfall; and the aspect of some of the rock-scoring is very recent.

II.—December 16th, 1903.—Sir Archibald Geikie, D.C.L., D.Sc., Sec. R.S., Vice-President, in the Chair. The following communications were read :—

1. "The Igneous Rocks associated with the Carboniferous Limestone of the Bristol District." By Professor Conwy Lloyd Morgan, LL.D., F.R.S., F.G.S., and Professor Sidney Hugh Reynolds, M.A., F.G.S.

Evidence for the contemporaneous origin of the igneous rocks is given for the following localities :—Middle Hope, or Woodspring; Spring Cove, near Weston-super-Mare; above Kew Stoke, Milton Hill; Uphill; Goblin Combe; and near Cadbury Camp. At Middle Hope the ejectamenta thin to the east, and lava is only found to the west; at Spring Cove small lapilli were found in the

limestone 8 feet above the basalt. At Goblin Combe there is the most characteristic and convincing section of ashy beds in the district: the lenticular bands of coarse greenish tuff, the limestone intercalations, the close admixture of lapilli, limestone fragments, and oolitic grains are stamped with the hall-mark of submarine volcanic action; lava closely underlies these breccias and tuffs. There is evidence of only one volcanic episode, which occurred in all cases after the *Zaphrentis*-beds had been laid down, and before the strata characterized by *Chonetes* and *Streptorhynchus* were deposited. (A table of certain broadly-marked horizons in the Carboniferous Limestone, by Mr. A. Vaughan, F.G.S., is given for reference.) The lavas are olivine-dolerites or basalts; with phenocrysts of olivine or augite. They are frequently amygdaloidal, sometimes variolitic; and in the variolites highly altered felspar-phenocrysts occur. The rocks vary in grain, the coarsest being those from Uphill and near Cadbury Camp, of the contemporaneous character of which there is no direct evidence. The tuffs are all highly calcareous, and most of them are best described as "ashy limestones." The bulk of the lapilli varies from one-hundredth part of the rock to about one-third, and their composition is closely related to that of the basaltic lavas of the district. Quartz-grains are abundant in the Goblin Combe rocks, and these rocks are frequently oolitic.

2. "The Rhætic Beds of England." By A. Rendle Short, Esq., M.B., B.Sc. (Communicated by Prof. S. H. Reynolds, M.A., F.G.S.)

The paper opens with a description of four new exposures of these rocks: one at Redland rests upon Carboniferous Limestone, and is interesting because the 'Bone-bed' is very ill-developed on receding from the old shore; a second is at Stoke Gifford, with a continuous, well-developed landscape marble, the Insect Bed, and no bone-bed; a third at Cotham Road (Bristol) yields baryta, celestine, and *Naiadita* at special horizons containing no other fossils; and the fourth, at Aust, has given measurements of the uppermost 13 feet, which are inaccessible from below. Next an account is given of the constituent beds, with special reference to the conditions of deposition. The Bone-bed is of wide distribution; it frequently occurs in pockets on a flat surface, or spread out over that surface; it contains fragments of rolled marl, rounded pebbles of Carboniferous Limestone, and pebbles of quartzite and well-rounded quartz. The author concludes that it was formed during a stormy period, after the sea had made its first irruption into the dried-up or silted-up level surface of the Keuper Lake. The *Naiadita*-beds appear to have been formed in very shallow, and perhaps only slightly saline, water, and the calcareous matter associated with them may have been mud washed from the Carboniferous Limestone. Only after the White Lias period did the water finally become moderately deep. The area of deposit appears to have been a gigantic shallow lagoon connected with the open sea to the south, and the fauna was derived from the direction of Germany. A short account is given of some of the Continental Rhætic formations, followed by a list of Rhætic

fossils recorded in England, with the range of each. A consideration of this list enables the author to suggest that the lower limit of the formation should be drawn at the first evidence of Rhætic life after the deposition of the gypsiferous and red or green marls, which (at any rate in their lower part) are certainly of Keuper age. The upper limit may, for convenience, be drawn at an indefinite level where *Modiola minima* and *Pleuromya crowcombeiana* become very rare, and the ammonitic and Liassic fauna begins. Further discussion of the lithological, physical, and palæontological evidence leads the author to recognize that the affinities of the Rhætic, thus defined, are rather with the Jurassic rocks than with the Trias. The following zones are suggested, in descending order:—

Zone of *Pleuromya crowcombeiana* = White Lias.
,, *Monotis decussata* = Cotham Marble and just above.
,, *Estheria minuta* var. *Brodieana*, and *Naiadita*.
,, *Pecten valoniensis*.
,, *Avicula contorta* = Black Shales and a limestone bed.
,, Bone-bed.

These zones seem to be fairly constant throughout England, and harmonize well with those of Germany, although they cannot be expected to fit in with the oceanic type of the Alps and the Mediterranean. Further consideration shows that the fossils give evidence of migration, but very little of evolution. The paper closes with the description of a new species of *Anomia* and a bibliography.

CORRESPONDENCE.

ATMOSPHERIC EROSION IN CORSICA.

SIR,—The remarkable mode of erosion described by Mr. Tuckett in the GEOLOGICAL MAGAZINE for this month is not uncommonly met with in the drier regions of the globe, and excellent examples are described and figured by Walther in his "Die Denudation in der Wüste" (Abh. k. sächs. Ges. Wiss., Math.-Phys. Classe, 1891) and "Das Gesetz der Wüstenbildung" (Berlin, 1900). Fig. 7 in the latter work presents a particularly close resemblance to the Tête de Chien. It is a reproduction of a photograph taken near the Indian desert.

Walther attributes the peculiar mode of erosion in these regions to the relative persistence of dew and other moisture on the shady side of the boulder or cliff, and its rapid evaporation on the sunny side. The shaded side consequently weathers much more quickly than the other, and the weathered material is removed by the wind.

In the Northern Hemisphere the cavities formed are generally, though not always, on the northern or western side of the rock; but from the shadows shown in Mr. Tuckett's beautiful photograph of the Tête de Chien, I infer that in this case the cavity does not face the north.

It would be interesting to learn whether the Corsican examples support Professor Walther's view. PHILIP LAKE.

13, PARK STREET, CAMBRIDGE.
January 15th, 1904.

OBITUARY.

PROFESSOR KARL ALFRED VON ZITTEL.

BORN SEPTEMBER 25, 1839. DIED JANUARY 5, 1904.

IT would be difficult to estimate the loss sustained by geological and palæontological science through the lamentable death of Professor K. A. von Zittel, of Munich, who for many years has occupied so eminent a position as a writer and teacher in these subjects, and has been rightly regarded as the most eminent of all exponents in the domain of palæontology. To those who are acquainted with the splendid work of von Zittel, the sudden termination of his brilliant career will come as a shock; among all who had personal dealings with the man himself, more especially the fortunate ones who, in the capacity of pupils, were privileged to enjoy the advantages of daily intercourse with a teacher so inspiring and so lovable, there will not be one who does not experience poignant regret and a genuine sense of personal bereavement.

To the Professor's rare personal qualities and the unfailingly cordial and courteous attitude he displayed towards colleagues and students, must in no small measure be attributed the great success achieved by the Munich school of palæontology during the long period of von Zittel's tenure of the chair. By his zeal and thoroughness in handling the subject to which he patiently and strenuously devoted so great a part of his energies, he directly accomplished much for science, but also afforded an example which must clearly have borne valuable fruits, especially when we note that his teaching was a reflection of his own admirable method. An exceptionally lucid and eloquent lecturer, Professor von Zittel regarded palæontology primarily in its correct aspect as an important branch of biology, and his influence was in no slight degree responsible for the important status which his special subject has attained among the sciences in Germany, a position which even yet seems to be most reluctantly accorded to it in this country. A striking feature of the late Professor's discourses on palæozoology consisted in the remarkably even treatment which he devoted to all parts of the subject; he seemed to possess an equally extensive knowledge when dealing in turn with each class of animals, while throughout his lengthy course of lectures his deliverances were frequently brightened by an inspiring enthusiasm.

Scrupulous thoroughness, accurate observation, and cautious interpretation were the principles upon which Professor von Zittel most strongly insisted; and if he hesitated to express himself concerning the philosophic and speculative aspects of his subject, and, in his published writings, maintained in regard to these a somewhat conservative attitude, we may perceive in this reticence evidence of that cautious and judicial spirit which has ensured soundness and lasting value in his own work and in that of many of his disciples. In an excellent article recently contributed to the columns of *Nature*, to which the present writer is indebted for

I remain yours sincerely

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some of the following biographical details, a passage is quoted from an address delivered by Professor von Zittel before the International Congress of Geologists in 1894, illustrating his attitude towards certain modern tendencies in the treatment of biology. In this he says: "The domination of the Linnæan and Cuvierian principles threatened systematic biology with soulless paralysis: the unbridled subjectivity of recent times may easily lead to anarchy." It is regrettable to have to add that in some departments of palæontology this prophecy seems already to have become fully realized.

Professor von Zittel distrusted voluminous and hastily produced work; to one so painstaking as himself, unsoundness owing to lack of care was sufficiently abhorrent. Yet he was a lenient and generous critic of work which, though imperfect, had been conscientiously achieved, and he looked with the greatest disfavour upon the kind of criticism which, betraying a needless spirit of antagonism, is couched in terms that might prove offensive or injurious. It is delightful to recall the kindly encouragement with which this gifted man assisted the circle of students at work in the palæontological laboratory at Munich and in the field, and to note that, however busily occupied with his own researches, he was at all times willing to lay his work aside in order to answer a question or to discuss some point with even the humblest of his students. This ready accessibility, coupled with his modest bearing and the deferential manner in which he expressed his own opinions or offered criticism in discussion, served to endear Professor von Zittel to the many who, attracted by his fame, journeyed from almost every quarter of the globe in order to pursue their studies under his direction. The confident and independent attitude which he directly encouraged by making his pupils feel that he discussed subjects with them as equals, would have been fostered in less degree by the adoption of a more purely didactic tone, and must be reckoned among the most valuable results of the training he imparted. It may be remarked that he entertained very liberal views on the subject of education, and warmly advocated the admission of women to the full privileges of the university courses in Germany.

Karl Alfred Zittel was born at Bahlingen, in Baden, on Sept. 25th, 1839, and was the youngest son of Dean Zittel, a well-known Protestant divine. In the latter end of 1857 he entered the University of Heidelberg, where he studied under Bronn and Leonhard, afterwards devoting a year to complete his academic studies in Paris under Hébert. While still there, during 1861, he published, in collaboration with E. Goubert, his first palæontological paper, a short pamphlet dealing with the description of fossils from the Corallian rocks of Glos. After leaving Paris, Zittel joined the Geological Survey of Austria as a voluntary assistant, and commenced active work in Dalmatia. In 1863 he qualified himself as a 'Privatdozent' in the University of Vienna, and, refusing the offer of a professorship in Lemberg, accepted a post as assistant in the Mineralogical Museum in Vienna (now the Royal Natural History Museum). In the same year Zittel left

Vienna to occupy the position of Professor of Mineralogy in the Polytechnic at Carlsruhe, but here also his sojourn was a brief one, and on the death of the renowned Albert Oppel he was appointed in the Autumn of 1866, at the early age of 27, to fill the vacant chair of palæontology in the University of Munich, at the same time taking over the charge of the State palæontological collection preserved in the Old Academy. It is interesting to record that the selection of so young a candidate for this important position was warmly supported by C. W. von Gümbel, who, as the revered veteran among Bavarian geologists, lived almost long enough to follow to its untimely termination the brilliant career of the man upon whom he so wisely bestowed his patronage. In 1880 the chairs of geology and palæontology became combined in the Munich University, and ten years later, on the death of Schafhäutl, Professor von Zittel was appointed keeper of the State geological collection also. It is well known with what enthusiasm he laboured in order to enlarge and perfect the museum under his charge, and how far, in face of great initial difficulties, he succeeded in bringing the Munich palæontological collection into the very first rank among similar institutions.

It may be said that from the time of his appointment at Munich Professor von Zittel's life was one of restless and fruitful activity. He had already completed a monograph on the lamellibranch molluscs of the Gosau beds, a memoir which amply illustrated his painstaking and precise method of work, and this was followed by his able and comprehensive study of the fauna and relationships of the Tithonian stage (1868–1873). Various other works in the field of palæontology showed the versatility of the writer, and included papers on representatives of vertebrate classes. Researches of a geological character resulted in the publication of a treatise on the glacial phenomena of the Upper Bavarian plain (1874–1875), and after accompanying the Rohlfs Expedition to the Libyan Desert (1873–1874), von Zittel in 1880 produced his well-known work "Ueber den geologischen Bau der Libyschen Wüste." The fuller results of his fruitful journey have appeared in the pages of *Palæontographica*, and include special studies of the collections of fossils obtained, the investigation of which was entrusted to several collaborators, and has only been recently concluded (1883–1902). In addition to his other labours Professor von Zittel, in the capacity of principal editor, successfully conducted the publication of the important *Palæontographica* from the year 1869 until the time of his death.

The work by which the late Professor made his name most widely known, however, was the great "Handbuch der Palaeontologie," which, begun in 1876, required seventeen years of strenuous labour for its preparation. An enormous amount of original investigation was necessitated during the compilation of this wonderfully complete compendium, and the most important of these incidental researches, that which dealt with the classification of the sponges, occupied no less than three years of the author's time, and resulted in the production of a monograph of great value, which was published by the Royal Bavarian Academy (1877–1879). The

"Handbuch" appeared in five volumes, four of which include the whole range of palæozoology, while the fifth volume, comprising palæobotany, was contributed by Schimper and Schenk. The publication of this work was the greatest service rendered by its author, and the famous "Handbuch" still remains the most comprehensive and trustworthy treatise of reference on the subject with which it deals. It was translated into French by Professor Charles Barrois.

Prompted, no doubt, by his own requirements as a lecturer, the Professor directed the publication of an extensive series of palæontological wall-diagrams to illustrate generic characters (1879–1891), which have been very widely appreciated by teachers. To meet a long-felt want, he published in 1895 the "Grundzüge der Palaeontologie," a volume most admirably adapted to the requirements of students, which embodies, though with some revision, the principal outlines of the author's larger treatise on palæozoology. The translation of this work into the English language was undertaken, with the collaboration of several specialists, by Dr. C. R. Eastman, and thus under American auspices the first part of it, comprising the Invertebrata, was published separately, though with such far-reaching modifications as to render the volume for practical purposes an almost entirely new work. Professor von Zittel himself only lived to superintend the issue of that part of the second German edition which deals with the Invertebrata, but in order to preserve those features whereby, according to his belief, the work would best retain its utility as a student's manual, he adhered to the scheme employed in the first edition.

A little book adapted to supply the needs of a wider circle of readers had been many years previously published by the Professor, under the title "Aus der Urzeit," and in this the author attractively described and illustrated the progress of development in the organic world from the earliest times onwards. This work became much in request, and, having passed through a second edition, has for some time been out of print. One other work from the pen of von Zittel calls for special mention. This is his well-known and valued History of Geology and Palæontology, in itself a striking monument of conscientious toil, which demanded several years of steady application in its compilation. The preparation of this volume was a labour of love with the author, whose wide literary knowledge, proficiency as a linguist, and keen interest in tracing out the course of development in the study of these sciences, specially qualified him for such a task. This reliable, comprehensive, and well-written work has been translated into English by Mrs. M. Ogilvie Gordon, and issued in somewhat abridged form. It has with some justification been maintained that in this book, as in so much of von Zittel's purely scientific writings, the character of the work suffered in a certain degree from the author's too strictly objective method of treatment; it was not that he lacked the critical or imaginative faculties, but we must rather suppose that the exercise of these was often purposely held in check in the endeavour to ensure an entirely truthful and precise presentation of facts.

Professor von Zittel's ability and industry were rewarded by the bestowal upon him of abundant honours; he received various orders and medals, and was elected an honorary member of numerous learned societies. He became a foreign member of the Geological Society of London in 1889, and in 1894 was the recipient of the Wollaston medal. In 1875 he was made an ordinary member of the Royal Bavarian Academy of Sciences, and in 1899, on the retirement of von Pettenkofer, was chosen to fill the presidency of the Academy, with the position of Conservator-General of the State scientific collections. An honorary member of the Royal Academy of Sciences in Berlin, he became a foreign associate of the United States National Academy of Sciences in 1898, and a corresponding member of the Paris Academy of Sciences in 1900. He was Rector of the University of Munich in the year 1880, and in that capacity delivered an able inaugural address which afterwards appeared in print, entitled "Arbeit und Fortschritt im Weltall." Some time afterwards he was awarded a knighthood, and it is many years since he was made a Privy Councillor.

Rest and change during last year seemed to have warded off the dangerous cardiac trouble with which Professor von Zittel had for a time been threatened, but before he had completely recovered from the effects of an unfortunate accident which befell him last October, he suffered a return of the serious symptoms, and passed away on January 5th, at the age of 64. A large and very representative gathering assembled to pay a last honour to the memory of the man who had so well merited the impressive eulogium which was delivered at the graveside on behalf of his sorrowing colleagues of the Academy of Sciences. F. L. Kitchin.

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